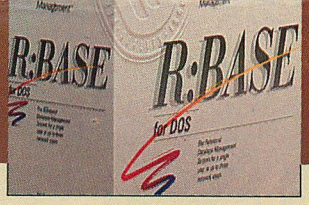
MICRORIM'S LATEST R:BASE ▶



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JULY 1988–FIFTH ANNIVERSARY

VOL. 6 NO. 7 $3.95

TECH PC JOURNAL®

FOR SYSTEMS DEVELOPERS AND INTEGRATORS

MAC CONNECTIONS

MACS IN A PC WORLD

3+ FOR MACINTOSH

DCA'S MACIRMA LINK

07

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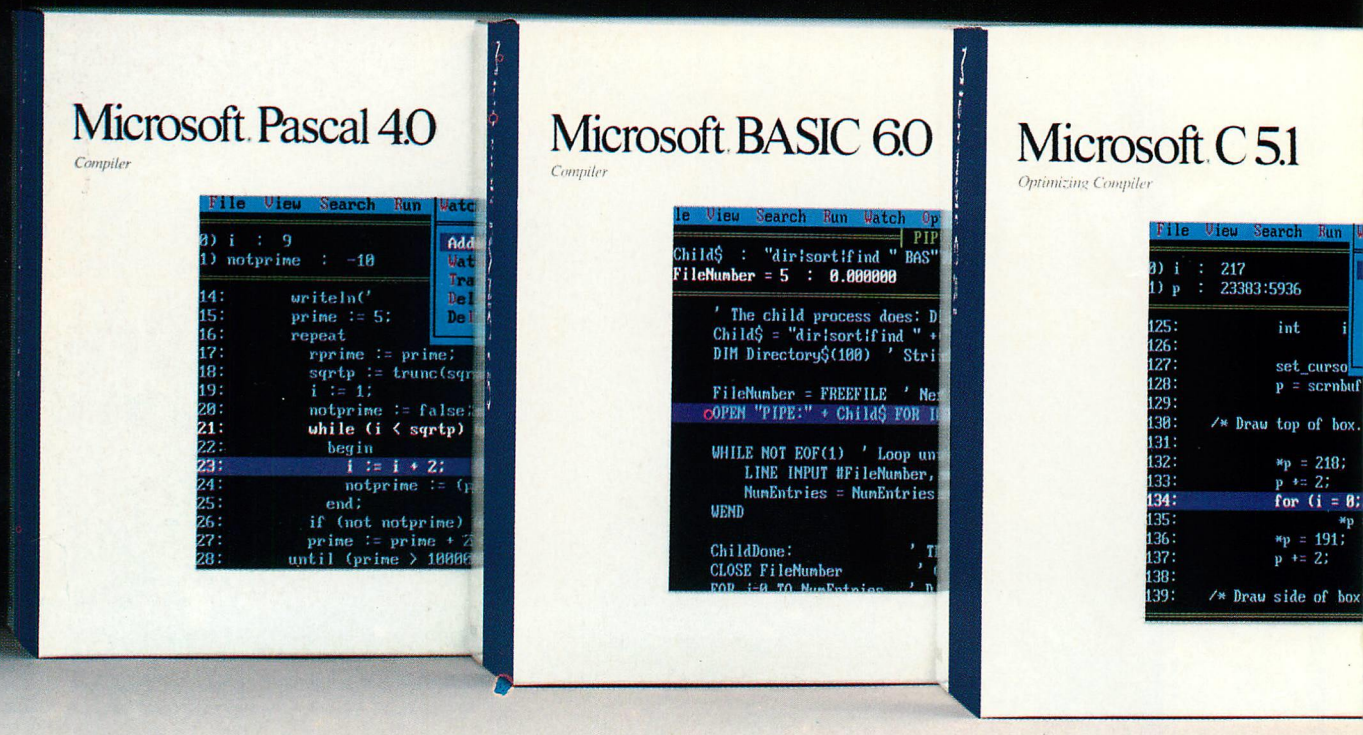
Introducing Mic for OS/2



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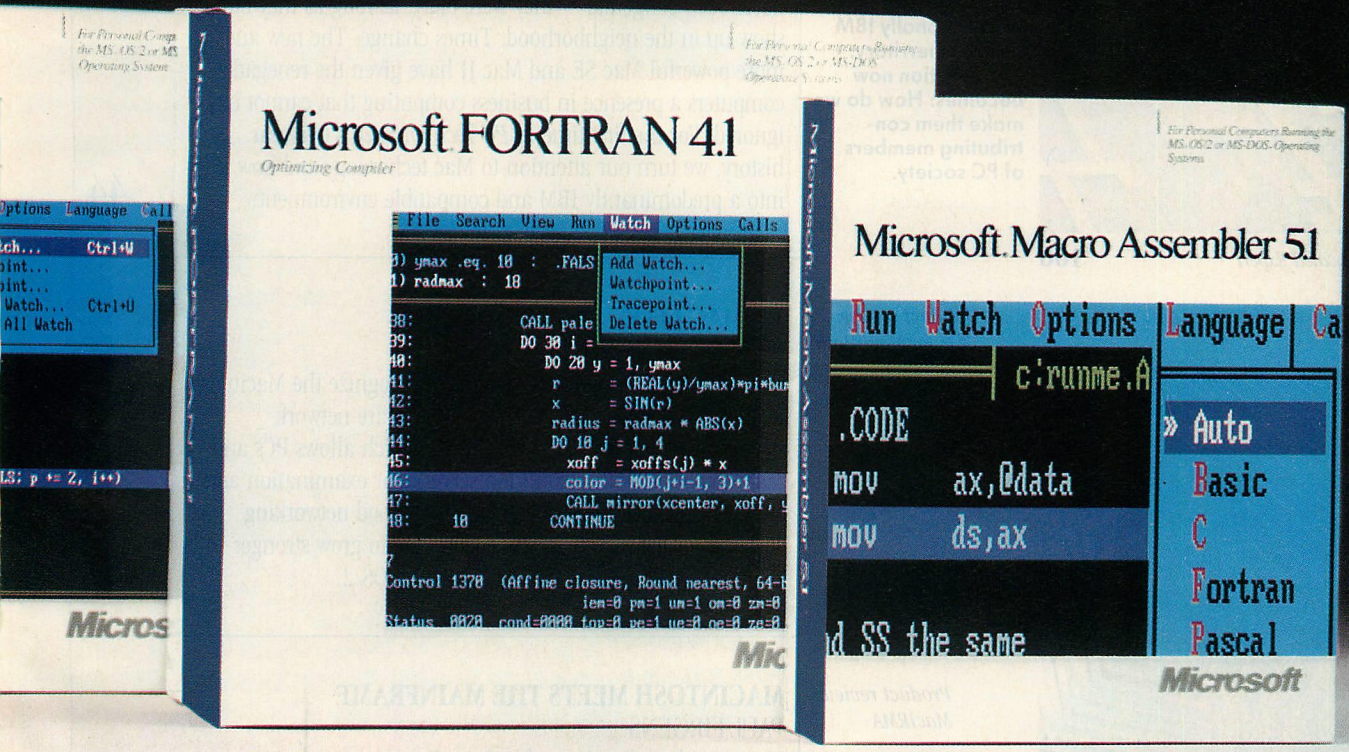

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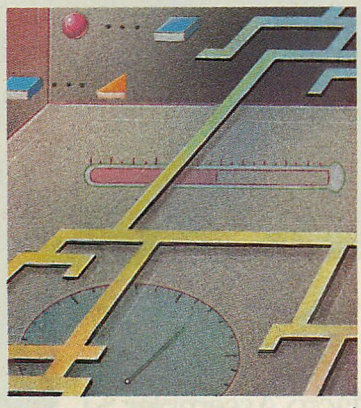


Sophisticated Expert **106**

COVER SUITE: MAC CONNECTIONS

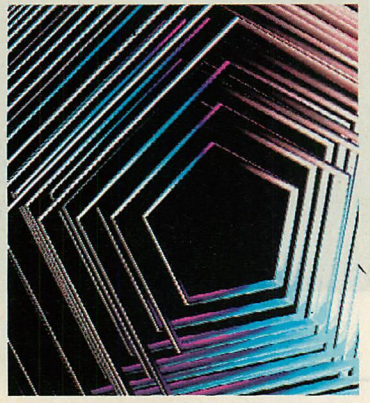
The Apple Macintosh is popping up on thousands of desks in traditionally IBM business territory. The question now becomes: How do we make them contributing members of PC society.

ENTER THE MACS

WILLIAM CASEY

The IBM world's attitude toward Macintosh computers has never been congenial—they were okay, as long as they didn't show up in the neighborhood. Times change. The new and more powerful Mac SE and Mac II have given the renegade computers a presence in business computing that cannot be ignored. For the first time in *PC Tech Journal*'s five-year history, we turn our attention to Mac technology and how it fits into a predominantly IBM and compatible environment. **44**

Product review: 3+ for Macintosh



The Evolution of R:BASE **86**

PC-MAC LINK

HOWARD MARKS

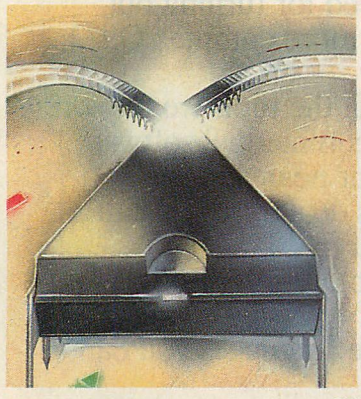
One of the first PC network vendors to recognize the Macintosh is 3Com. The latest extension to its 3+Share network operating system is 3+for Macintosh, which allows PCs and Macs to coexist with a common server. Our examination and LAN performance tests show this to be a good networking solution for the mixed environment, sure to grow stronger with the multitasking and memory features of OS/2. **52**

Product review: MacIRMA

MACINTOSH MEETS THE MAINFRAME

PAUL FIRGENS

Mac users have been out of luck in the corporate environment in which an IBM mainframe looms over them. DCA comes to the rescue with MacIRMA, a 3270 terminal emulator. We test it on a Mac II and find that MacIRMA gives Mac users the same access to data as PC users have long had—and represents a giant step toward corporate acceptance of the Macintosh. **66**



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OPERATING ENVIRONMENTS

EMS 4.0 PULLS TOGETHER

TED MIRECKI

EMS 4.0 melds the best of the earlier Lotus/Intel/Microsoft version and the enhanced version from AST/Quadram/Ashton-Tate into a new and improved expanded memory specification. This blessed union provides a memory standard and task-switching capability that should mean a brighter future for those developing DOS applications. **72**

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R:BASE for DOS
R:BASE for OS/2

THE EVOLUTION OF R:BASE

VICTOR E. WRIGHT

Following the theory of natural selection, Microrim has held on to the strongest traits of its popular data manager through its many iterations. Its two latest versions, R:BASE for DOS and R:BASE for OS/2, keep the robust language and flexible generator, adding a prompt-by-example interface and SQL features. We run R:BASE for DOS through our usual data manager tests and take a separate look at the OS/2 version. 86

EXPERT SYSTEMS

Product review:
PC Plus

SOPHISTICATED EXPERT

SUSAN J. SHEPARD

A veteran in the expert-system business, Texas Instruments is well-positioned to deliver an expert system shell for the PC. Its Personal Consultant Plus has helped build expert systems in fields as diverse as accounting, grain marketing, and airline-gate scheduling. We give you the details we found in developing a sample diagnostic system for diesel automobile engines. 106

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SYSTEMS PERSPECTIVE

Mac Comes to Town/JULIE ANDERSON

Not so long ago, a Macintosh within our pages would have been heresy. Today we see the Mac as a serious player in a multivendor environment, and we must learn to integrate. 9

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The computer industry has grown more complex since our first issue exactly five years ago, but we still bring you the most detailed, accurate technical information. Here's how. 25

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Cover Illustration · Ned Shatzer

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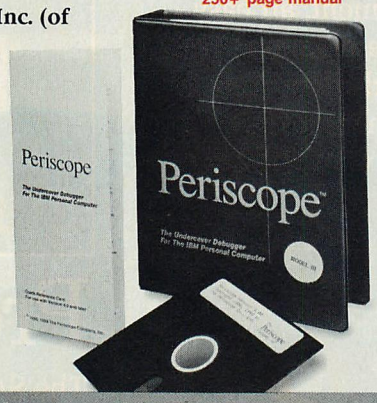


David Nanian, President of Underware, Inc. (of BRIEF fame) says this about the new Periscope Version 4:

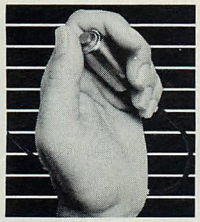
"Periscope has always been an unbelievable assembler-level debugger. Version 4 has turned it into a terrific source-level debugger as well. Aside from major enhancements like the source-level improvements, all the little changes make a really big difference, too. For instance, symbol lookups and disassemblies are noticeably faster, and highlighting the registers that have changed really makes life easier. Once again, Periscope has raised the industry standard for debuggers!"

Periscope's software is solid, comprehensive, and flexible.

It helps you debug just about any kind of program you can write... thoroughly and efficiently.

Periscope's the answer for debugging device-drivers, memory-resident, non-DOS, and interrupt-driven programs. Periscope works with any language, and provides source and/or symbol support for programs written in high-level languages and assembler.

Periscope's hardware adds the power to solve the really tough debugging problems.

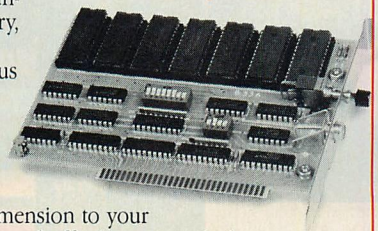


Periscope Break-out Switch

The break-out switch lets you break into the system any time. You can track down a bug instantly, or just check what's going on, without having to reboot or power down and back up. That's really useful when your system hangs! The switch is included with Periscope I, Periscope II, and Periscope III.

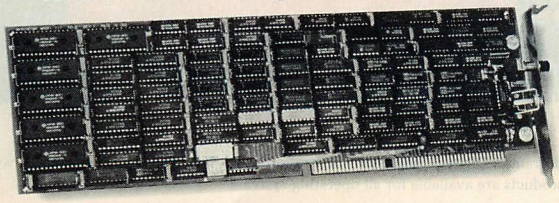
Periscope I has a board with 56K of write-protected RAM. The Periscope software resides in this memory, safe from run-away programs. DOS memory, where debugger software would normally reside, is thus freed up for your program.

Periscope I Board



Periscope III has a board with 64K of write-protected RAM, which performs the same function as the Periscope I protected memory. AND...

The Periscope III board adds another powerful dimension to your debugging. Its hardware breakpoints and real-time trace buffer let you track down bugs that a software-oriented debugger would take too long to find, or can't find at all!



Periscope III Board

What's New in Periscope Version 4:

- View local symbols from Microsoft C (Version 5)
- Debug Microsoft windows applications
- Set breakpoints in PLINK overlays
- Improved source-level support
- Monitor variables in a Watch window
- 80386 debug register support
- Debug using a dumb terminal
- PS/2 watchdog timer support
- Use mixed-case symbols
- Set breakpoints on values of Flags
- Much more!

- **Periscope I** includes a half-length board with 56K of write-protected RAM; break-out switch; software and manual for $345.
- **Periscope II** includes break-out switch; software and manual for $175.
- **Periscope II-X** includes software and manual (no hardware) for $145.
- **Periscope III** includes a full-length board with 64K of write-protected RAM, hardware breakpoints and real-time trace buffer; break-out switch; software and manual. Periscope III for machines running up to 10 MHz is $1195.

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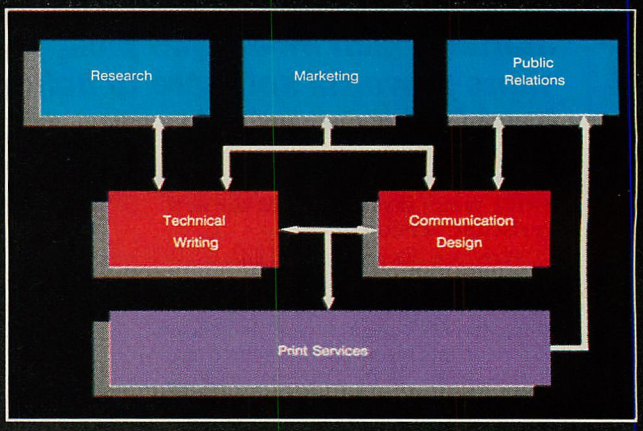

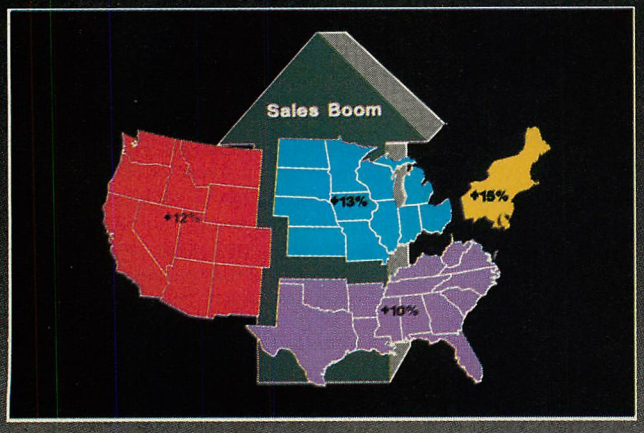

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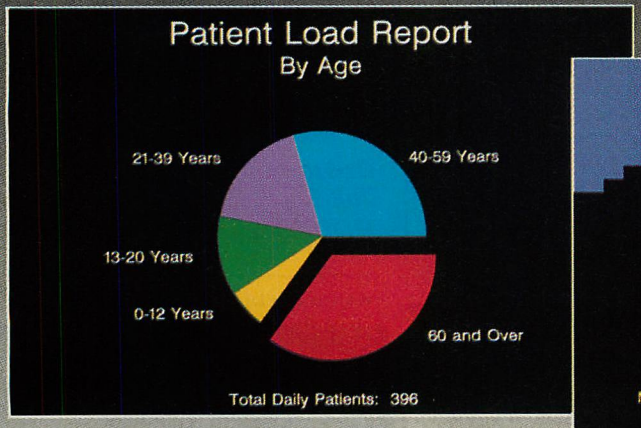

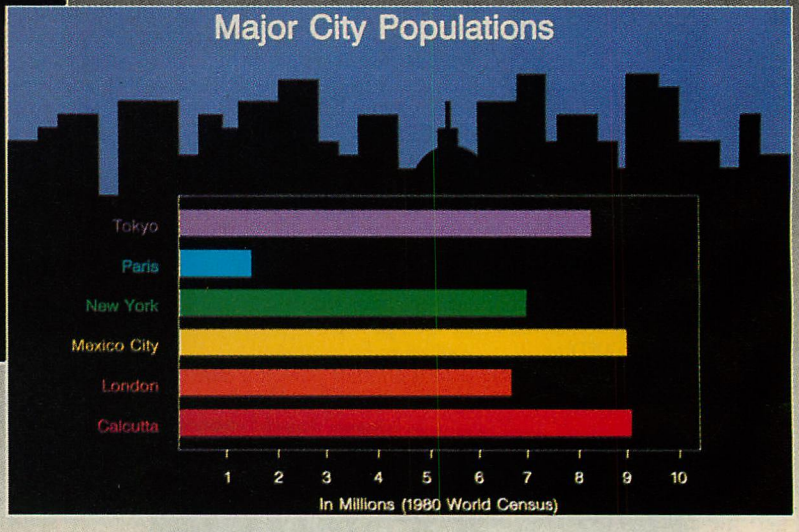

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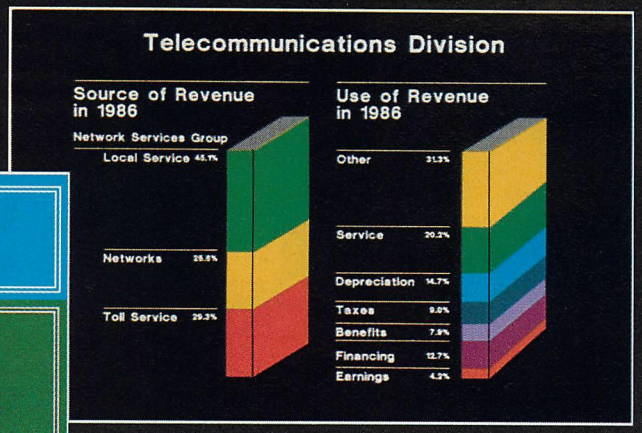

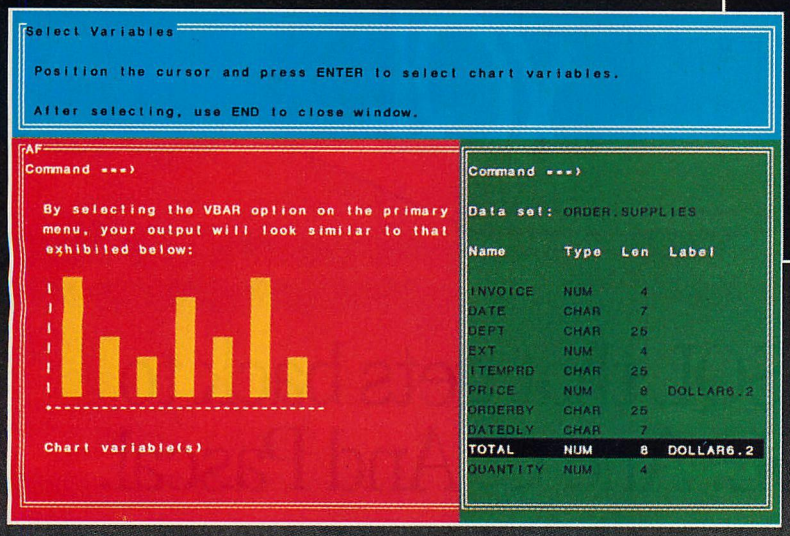

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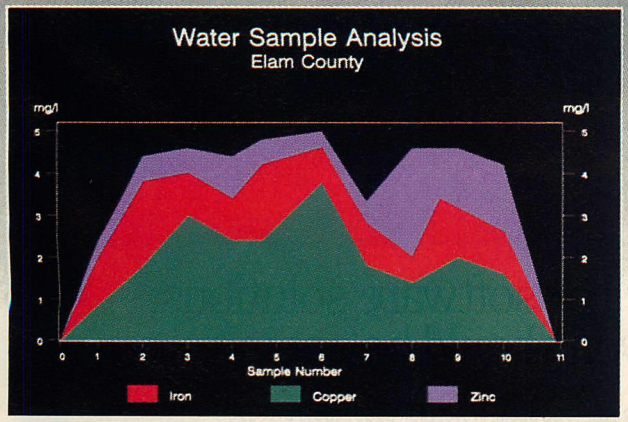

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JULIE ANDERSON

SYSTEMS PERSPECTIVE

Mac Comes to Town

The Macintosh is here, with serious intentions, and the PC world must take serious notice.

An Apple Macintosh on the cover of *PC Tech Journal*'s fifth anniversary issue may surprise some of you. It took us a while to get used to the idea ourselves. But the Mac on the cover is not meant to shock—only to show how much we and the computer industry have evolved since our first issue in July 1983.

In the beginning, the only desktop computers considered worthy for business applications were those stamped with the IBM label. Gradually, Compaq and a few other IBM compatibles manufacturers gained the respect of business by producing reliable computers with added features at lower prices.

Incompatibilities were rare, even when the market was flooded by clone manufacturers who produced commodity items with proven BIOS and off-the-shelf hardware components. The risk in buying a non-IBM machine was no longer the big issue it once was.

It is this maturing of the manufacturing arm of the industry plus years of increasing confidence in microcomputers that allows the Mac, which is a wholly different architecture, to gain a foothold in corporations. Our research shows that Macs have penetrated about 20 percent of our readers' companies—a presence we cannot ignore.

The question is, just how should *PC Tech Journal* treat the Mac. Because the magazine's mission is to cover issues of systems design, development, and integration, the answer, of course, depends on how businesses are using their newly acquired Macs.

At the MacWorld show in San Francisco in January, I asked many attendees what they do with their Macs. Their answers revealed two primary applications. The first and most obvious is in-house desktop publishing. The Mac's graphics are visually enticing to artists and some would-be artists, and the large-screen monitors available from Radius Inc., SuperMac Technologies, and other companies make true WYSIWYG possible.

The other popular role for the Mac is as a low-end CAD workstation. Again, graphics capabilities are a key factor. And when the Mac is outgrown, a natural migration path leads to the more powerful Sun workstation.

In more isolated cases, the Mac is serving as a personal productivity station. Chosen for its ease of use and reduced training requirements, the Mac is certainly adequate at running spreadsheets and word processors on the nontechnical end user's desk.

Regardless of the reason Macs got in the door, their users now want to be connected into the "real" data. They need to publish graphs based on corporate numbers, determine costs of CAD designs, and share documents with their PC-owning colleagues.

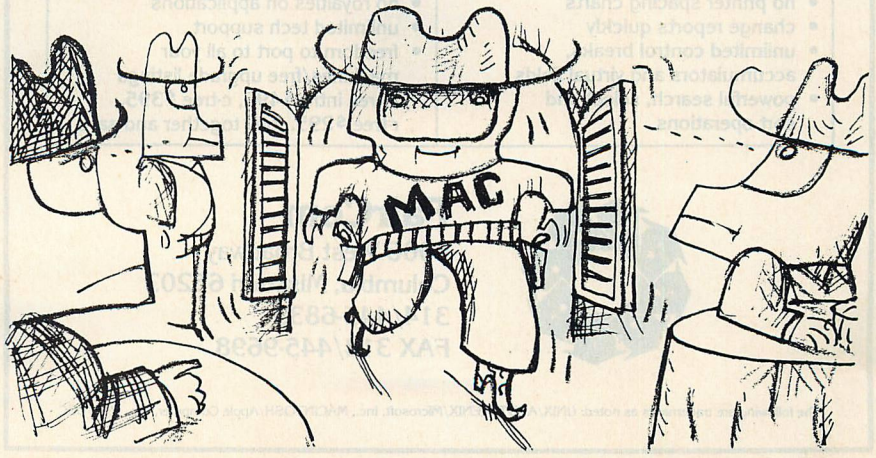
The focus of our cover suite this month, therefore, is how to connect these Macs that have crept into the corporation with work-group and corporate data. The first article, "Enter the Macs," by William Casey, describes the Macintosh line and presents options and problems in connecting Macs to PCs. In "PC-Mac Link," Howard Marks examines 3Com's 3+ server software that allows Macs and PCs to reside on the same network and share resources. Finally, Paul Firgens looks at Mac-3270 connections ("Macintosh Meets the Mainframe"), comparing DCA's MacIRMA to its IBM sibling.

Our intent in this coverage is not to sell you on Macintosh computers, but to recognize that the days of single-architecture microcomputers are gone. The question is not which architecture will win out, because I don't believe any one architecture will prevail. The issue today is how to manage multiple architectures so that they can effectively coexist in one system.

As much as the industry and end users cry out for standards, the best that we can hope for is a family of standard platforms with a family of standard interfaces that allow the platforms to exchange data. This means that workstations with different architectures need to interface with each other at the hardware, operating system, and application levels.

DEVELOPING, ANYONE?

Our cover suite focuses on *integrating* Macs, because few companies are using them for developing. Our research shows only about 15 percent of our readers are developing on the Mac, and I could find no companies at MacWorld



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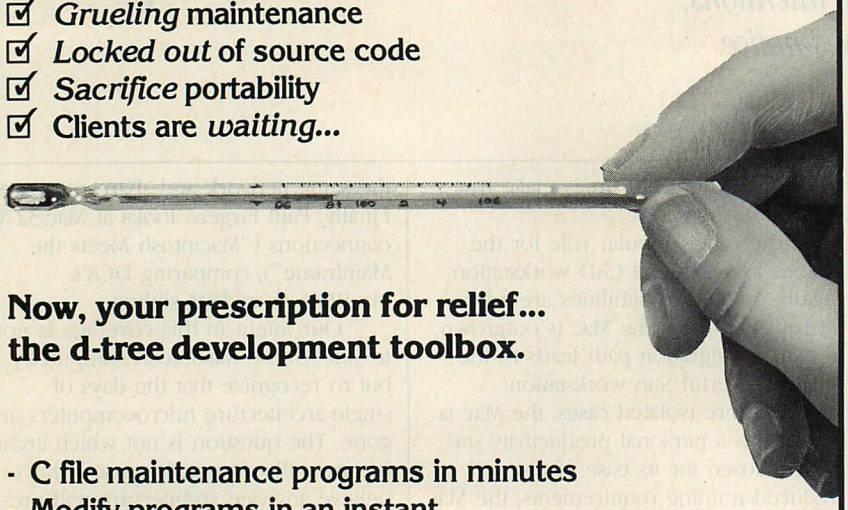

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that were. This should not be surprising; only recently have Fortune 1000 corporations embraced the PC for developing strategic business applications. Exacting security requirements and the lack of sophisticated operating systems had kept most such development on larger computers. Now, powerful 386 machines with 300MB disks, sophisticated operating systems in the forms of OS/2 and UNIX, more advanced development tools, and the promise of an easy-to-use graphics interface are making the PC increasingly attractive for development.

The Mac will likewise have to prove itself before it is widely accepted for developing applications. Ironically, with the PC breaking ground, the Mac may have an easier row to hoe.

THOSE WHO WERE THERE

A magazine's turning 5 is a coming of age. As we celebrate our fifth anniversary, Will Fastie, founding editor and current editorial director, and I would like to recognize the long-term contributions of some editorial staff members who have been with *PC Tech Journal* for most of its five years.

Susan Holly, who began four years ago as senior copy editor and now is executive editor, supervises the associate editors and copy edit staff and guides each article through to publication. She has the final word on our journalistic style and substance.

Gail Shaffer, who also joined us four years ago in the copy edit department, was recently promoted to senior editor. She teams up with the technical editors to assure that our technical detail is communicated clearly.

Our distinctive artistic look is due to the efforts of art director Sharon Reuter, a three-year veteran of the magazine's staff. She creates the clean design that helps you navigate easily through the magazine's pages.

New products editor Carole Eyring, who has seen us through 4½ years, is as well-known to vendors in the computer industry as *PC Tech Journal* itself. Carole compiles our Tech Releases section each month and is our liaison with vendors, tracking new developments in the industry.

These people, who have been with us the longest, join with the rest of our talented editorial staff—now numbering 24—to bring you the highest-quality magazine possible. We have come a long way from *PC Tech Journal*'s first formative months in Will's basement five years ago.

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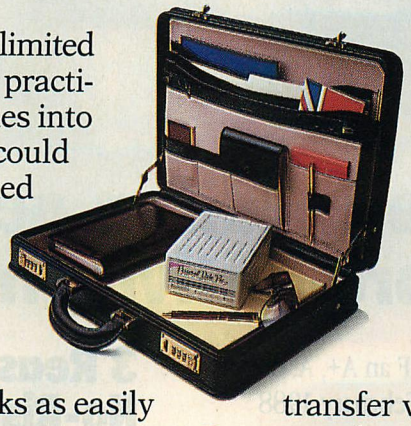

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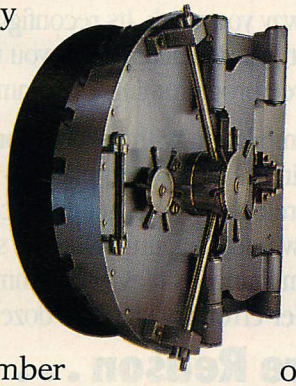

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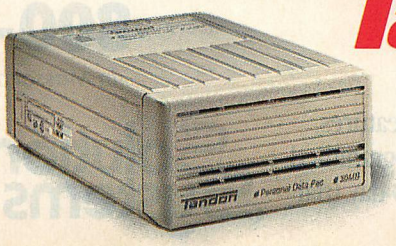

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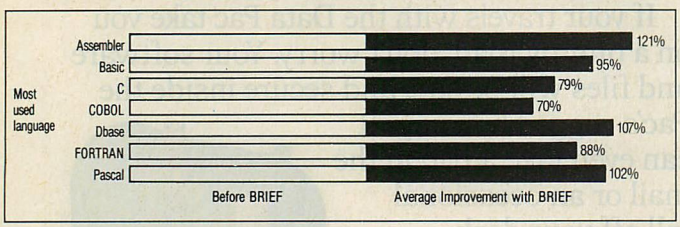

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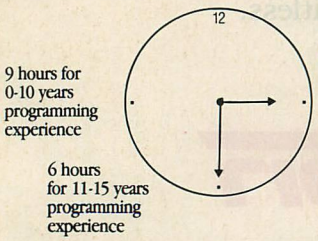

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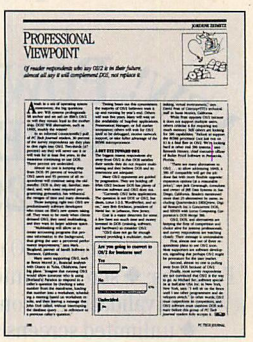
LETTERS

PROFESSIONAL VIEWPOINT

The C controversy: two of three survey respondents endorse C, despite hard knocks against it.


PROFESSIONAL VIEWPOINT

Of reader respondents who say OS/2 is in their future, almost all say it will complement DOS, not replace it.

Several readers have told us our monthly reader opinion cards do not provide enough space for them to answer. While we report on your responses each month in Professional Viewpoint, we cannot publish the many articulate opinions we receive in that one-page department. Therefore, we present here a few of the letters generated by those cards. —*JA*

THE DOS CONTINUUM

The reader opinion card (bound in the January 1988 issue between pages 8 and 9) asked the questions: "Are you going to convert to OS/2 for business use?" and "Will you continue to use DOS?" Here is my full response.

I will continue to use DOS even while recognizing that DOS is nothing but a series of patches upon patches of the body politic of CP/M. It is familiar and effective, even though most users do not know how to use some of the fine features of this hybrid old-timer.

I will continue to use UNIX as well because it is superior to DOS in some ways, even though its creators have not been smart enough to sweeten its appearance so that it might appeal to a broader audience.

OS/2 is yet another milestone in the IBM saga of using bright people to produce mediocre products. One only has to look at its predecessors—the PC*jr* fiasco, the low-tech Models 25 and 30, and the sluggish hard-disk drives of the Models 50 and 60—for proof.

The reduced instruction set command (RISC) computers are the next real wave to come. The little $500 Acorn from England can probably outperform a domestic 12-MHz 386 with no problems. When we finally decide that the RISC architecture is really where it is at, we will also find that, once again, Europe and the Far East have beaten us to the punch.

Allan S. Joffe
Dresher, PA

In reply to your question, "Are you going to convert to OS/2 for business use?": In short, the answer is yes. We will start to plan actively for conversion to OS/2 when version 1.1 with LAN Manager is available, and we probably will begin the conversion in the first quarter of 1990. By that time, OS/2 should be somewhat stable, and some meaningful (not necessarily compelling) applications should be available. We will convert because we will have to, for the same reason that we could not have stayed with DOS 2.0.

No, we will not continue using DOS. As we migrate to OS/2, we will cast off DOS, so that eventually all of our machines will be running OS/2. It would be too difficult to support two such dramatically different operating systems at the same time.

Longer answers to the question make more sense in the context of what our company is doing with its computers—how they are currently being used, how we want them to be used, and how they help us meet our business objectives.

We have an extensive investment in off-the-shelf software including Lotus 1-2-3, Microsoft Excel, Microsoft Word, dBASE III, Open Systems Accounting, Crosstalk Mark IV, and so on.

More importantly, we have an even larger investment in software developed in-house. Because of our foreign exchange orientation (we are a foreign exchange and precious metals firm), we have had to develop our own software, mostly in Microsoft C and assembly language, using Btrieve as the low-level file manager. By 1990, we will have anywhere from 500,000 to 1,000,000 lines of in-house code.

OS/2 1.0 is not compellingly faster than DOS 3.3, it does not support connectivity beyond what one can do now, and the file sizes and disk volume constraints are the same (Compaq's DOS 3.31 notwithstanding).

On the other hand, OS/2 does support multitasking, which we currently do not need. From an application development perspective, OS/2 supports libraries linkable at runtime (as opposed to link time) and threads, and I imagine a few other goodies. But for now, the pain of conversion gives us so little added benefit that, frankly, it is not worth it.

We will begin converting when we feel that we are converting to a "standard" and when we can do so safely. We are not in a position to experiment. This is premised on the following:

- That Novell's NetWare will support it—or whatever network operating system we have at the time (and NetWare looks like a good bet). We are upgrading to SFT NetWare 2.1 in the next month. Novell, of course, has said all the right things about supporting OS/2; on the other hand, it promised SFT Level III two or three years ago, so who knows.
- That OS/2 will not compromise the speed of our transaction-based programs. Right now we can do a maximum of 5 to 10 transactions per second, depending on system load. Any individual workstation can read between 30 and 50 records per second from files that are several megabytes in size (updating and insertion of course take longer, only 2 to 10 records per second, depending on configuration, load, initial file size, and so on). We don't want to give up these capabilities.
- That we don't have to throw away our old machines. Buying additional memory boards and monitors is one thing; throwing out $150,000 of computer equipment to buy some more is another.
- That programming tools, including languages and debuggers, are available. For example, right now, apparently the only way to debug a Windows application is to connect an-

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other machine to yours and pipe the debugger's output to the screen on the second machine. That is not my idea of a good time.

The more value we feel we get in switching to OS/2, the sooner we will do it. The less value, the longer we will defer conversion until we absolutely have to.

Ronald Szoc, Ph.D., vice president
Ruesch International
Washington, DC

PS/2 PROVOCATION

This letter is written in response to the opinion card in the April 1988 issue that asked your readers to rate the PS/2 family and its major components—namely, the VGA, 3.5-inch diskettes, and the Micro Channel.

It seems to me that by examining several of the new features of IBM's PS/2s, we can pinpoint the reason that IBM has had trouble convincing users that the Micro Channel is a major improvement to the IBM standard.

Look at three major components you asked us to rank. Ask three questions about each: 1) How compatible is it with the old standard? 2) How vocal is its opposition? and 3) How stiff is its competition?

VGA is compatible with all that has come before, and it has been embraced by all of the video vendors. They all realized that they could clone the VGA easily and thus were quick to abandon EGA in favor of VGA. With virtually no competition, VGA has become the new standard almost overnight.

The 3.5-inch format also has been embraced by all major manufacturers. Its technical advantages are obvious; even the fact that it is completely incompatible with the old format has not stopped it from being accepted.

The Micro Channel is incompatible with the old bus, and it presents major difficulties (mostly legal) for would-be cloners. As a result, they have worked hard to get users to stay with the old standard, largely successfully. The incompatibility of the Micro Channel, combined with the very effective competition, has held it back enormously.

IBM has no way to make the Micro Channel more compatible with the old bus. While the evidence shows (look at the 3.5-inch diskettes) that the difficulties of converting will not hold back a user who sees the advantage of changing, these difficulties *do* make it easier for other vendors to compete.

The only thing IBM can do to help make the Micro Channel a success is to encourage other vendors to clone it. Ironically, if IBM's competition were able to sell the Micro Channel in their own products, competition on the basis of the bus would disappear, and IBM could find itself with a much more successful product.

However, my analysis ignores two significant points. First, users have to see an advantage to moving to the new bus. IBM must begin to provide that advantage, in the form of significant new products that take advantage of the Micro Channel. Second, allowing other vendors to use the Micro Channel in their products means that IBM will be back in the same competitive position from which it was trying to escape when it introduced the new bus. It looks like IBM may have miscalculated—it didn't realize how important their competition was in helping to maintain the standard.

J.F. Gilliland
B.P. America
Cleveland, OH

SCRUTINIZING C

In response to your query regarding how the C programming language meets my needs (reader opinion card, February 1988)—C meets many of them, but it has severe deficiencies in some critical areas.

My opinion of high-level languages was profoundly shaped in the early 1970s when I became proficient in PL/1 using the IBM PL/1 optimizing compiler. Whether the task dealt with high-level abstractions or low-level bit-fiddling, the PL/1 was there.

This experience affected my attitudes toward programming in general and languages in particular. My precepts include:

- Portability is not always desirable nor possible. Some things will always have to be rewritten in order to make use of some particular hardware. Where products are developed specifically with portability in mind, performance seems to suffer.
- The best programmers are those who know how computers really work. They also know their compilers (the quality of code and the compiler libraries—not the command-line switches) the best.
- The best programs are those that create an environment that expresses the way users think and work.
- The best programmers don't always write the best programs.
- The best programs are not necessarily "best" for everyone.

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OS/2

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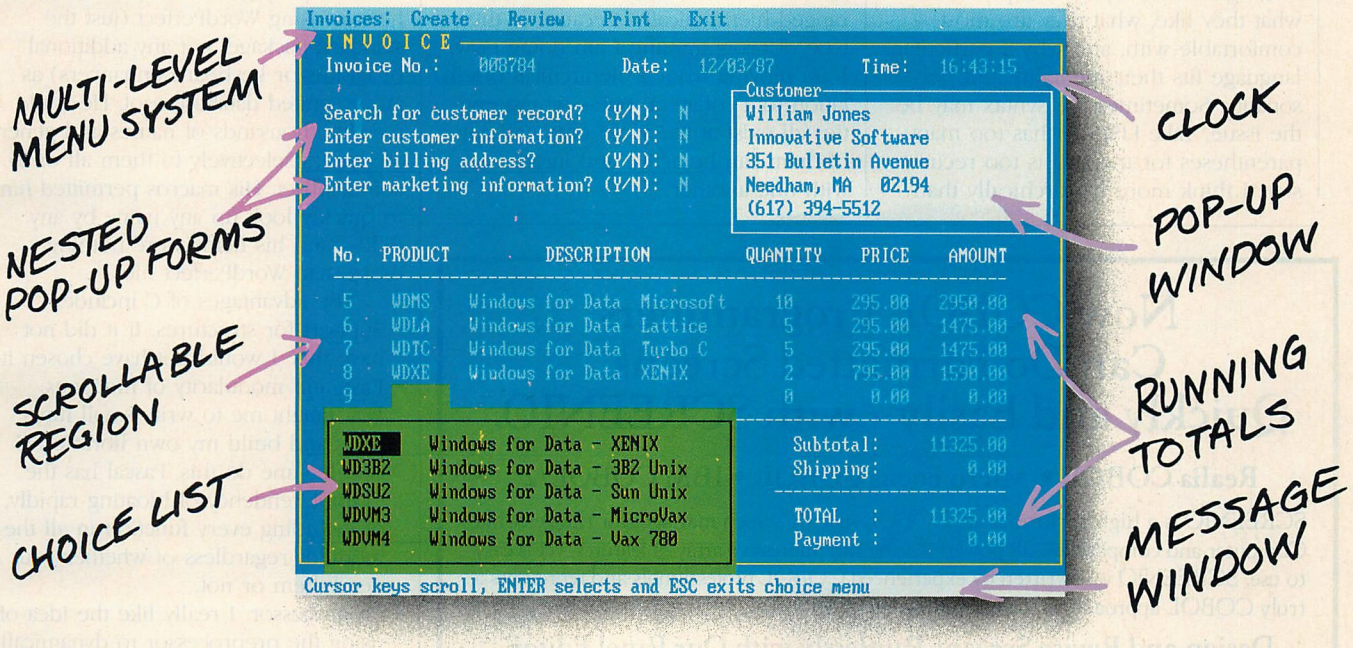

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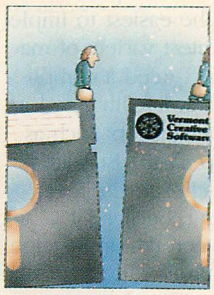

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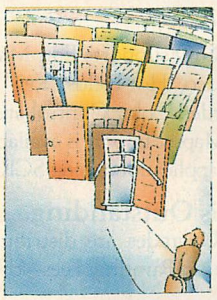

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- The best programs are not always written in the best languages.

Any discussion of language is actually a discussion of how some programmers do their craft, not of absolute rights and wrongs. People reveal what they like, what they are most comfortable with, and why a particular language fits their mentality and personality. Sometimes the syntax may be the issue. Take LISP—it has too many parentheses for me and is too recursive. I think more hierarchically than recursively, so I can't think in LISP terms; I can't write LISP statements.

I feel more comfortable with procedural languages that have conditional statements, ways of selecting among several alternatives, and that can be arranged hierarchically. Because of the type of programming I am doing now, I am moving from a hierarchical orientation to a collateral one—where entities all exist at the same time and any of them can be active and interrelate with one another.

As another example of being comfortable, I have a friend who does not know much about computers. He bought one machine and acquired WordPerfect to help run his business. He eventually got to the point where he was using WordPerfect (just the standard package, not any additional programs or keyboard enhancers) as an integrated database tool. He could manage thousands of names and generate letters selectively to them all or to some subset. His macros permitted him to quickly look up any name by any field—and his fields were nothing more than WordPerfect files.

The advantages of C include:

- Support for structures. If it did not have this, I would not have chosen it.
- Ease and modularity of functions. PL/1 taught me to write small functions and build my own libraries. C also lets me do this. Pascal has the COBOL tendency of bloating rapidly, of including every function in all the modules regardless of whether you need them or not.
- Preprocessor. I really like the idea of using the preprocessor to dynamically compile differently depending on other conditions. This was one area where PL/1 was sorely deficient. The PL/1 preprocessor was difficult to understand, difficult to use, and too much of a potentially good thing.
- Availability of add-on libraries. Because of the ease with which functions can be accessed in C, there seem to be more add-on libraries for C than for other languages.
- Flexibility. More than anything else, C gives me the feeling that PL/1 had given me in the old days: that I could do anything I wanted.

The deficiencies in C include:

- Simplistic file structures. This is the "file sequence of bytes" problem. Granted, this is the easiest to implement on the greatest variety of machines, but when I need a complicated file structure, I really need it. Resorting to file managers such as Btrieve (if it weren't for Btrieve, I would not have chosen C either) doesn't quite do it, because it is another layer between the application and the data. Complex file structures should be in the operating system and in the language. In this area, C reflects the simplistic approach to I/O of UNIX, which was developed in a computer science environment. OS/2 does not seem to portend a different future. Here is where I miss the mainframe world the most.

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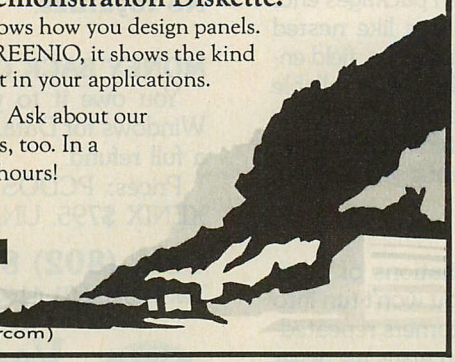

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- Not enough business data types. I would love to have the implementation of BCD data type, similar to the Fixed Decimal type of PL/1 or to the packed decimal of the IBM 360 instruction sets—and one where I can set the number of digits that I need. Yes, I know that I can write my own BCD functions, or perhaps buy some, but I want to do the BCD arithmetic directly: not

```
encode + bcd_add(result, a_num,
  b_num)
```

but instead,

```
result + a_num + b_num
```

- Inadequate I/O. In PL/1, I could format data in at least three ways: unformatted (binary, floating point, string, and so on); with format statements similar to those used in FORTRAN; or with pictures (similar to those used in COBOL). One could, for example, declare a structure that corresponds to a line of output. By assigning program variables to the members in the structure, one could achieve in-line conversion to the picture (the 360/370 instruction sets support this kind of conversion elegantly) and output it via in-line I/O instructions. That technique results in truly fast I/O.

So why will I continue to use C? I use it mostly because of its flexibility, because even IBM is putting its money in the C language of OS/2 and beyond, and because a decent PL/1 compiler is not available.

Now we have the situation where the C language is no longer, by and large, connected with the UNIX operating system. It exists in its right with its own force. That is all to the good—it just needs to be made better. IBM could surprise us all and give us that PL/1 compiler that must be filed somewhere in Boca Raton, Hursely, or Armonk under "Micros-Languages."

Ronald Szoc, Ph.D., vice president
Ruesch International
Washington, DC

TURNED ON

We are currently attempting to determine if turning on and off CRTs, PCs, printers, and monitors to reduce energy costs will be offset by possible damage to this equipment.

From the surveys of other data processing centers and hardware vendors, we have found a split opinion on the subject. Those who support turning off the equipment have been unable to provide any documentation to support their beliefs. Those who oppose turning off emphasize the shortened life of the hardware due to numerous power surges from the practice of powering on and off. Again, those who oppose, are unable to provide documentation.

We plan to incorporate a company-wide policy of only turning equipment off when leaving at night and turning it on when arriving in the morning. Any documentation that supports either side would help us.

Harold Peterson
Financial Information Trust
Des Moines, IA

We were unable to locate documentation supporting either opinion. However, your proposed policy of turning equipment on in the morning and off in the evening is a reasonable compromise between the cost of keeping equipment powered on continuously and the component stress incurred each time power is turned on or off. Leaving equipment powered on 24 hours a day is not recommended unless appropriate fire-safety measures are followed.

—JS

ERRATUM

The author of the MicroCache (Microcosm Research) review in Product Watch (May 1988, p. 153) was incorrectly identified. The author was Paul Firgens, a regular contributor to this magazine. *PC Tech Journal* deeply regrets the error.

COMMENTS, TIPS WELCOME

All letters to the editor should be directed to Editor, *PC Tech Journal*, Suite 800, 10480 Little Patuxent Parkway, Columbia, MD 21044. Correspondence also can be submitted over MCI Mail to PCTECH. Please keep letters brief and include name, mailing address, and telephone number; when a letter is lengthy, a diskette is appreciated.

Readers are also invited to submit short solutions to technical problems that are appropriate to the technical expertise of our audience. Submit these items to the attention of Ted Mirecki, at the same address. Illustrations by code fragments or *short* complete programs are welcome. Text files may be in WordPerfect, Word, WordStar or plain ASCII format; source code must be plain ASCII ready for input to a compiler or assembler.

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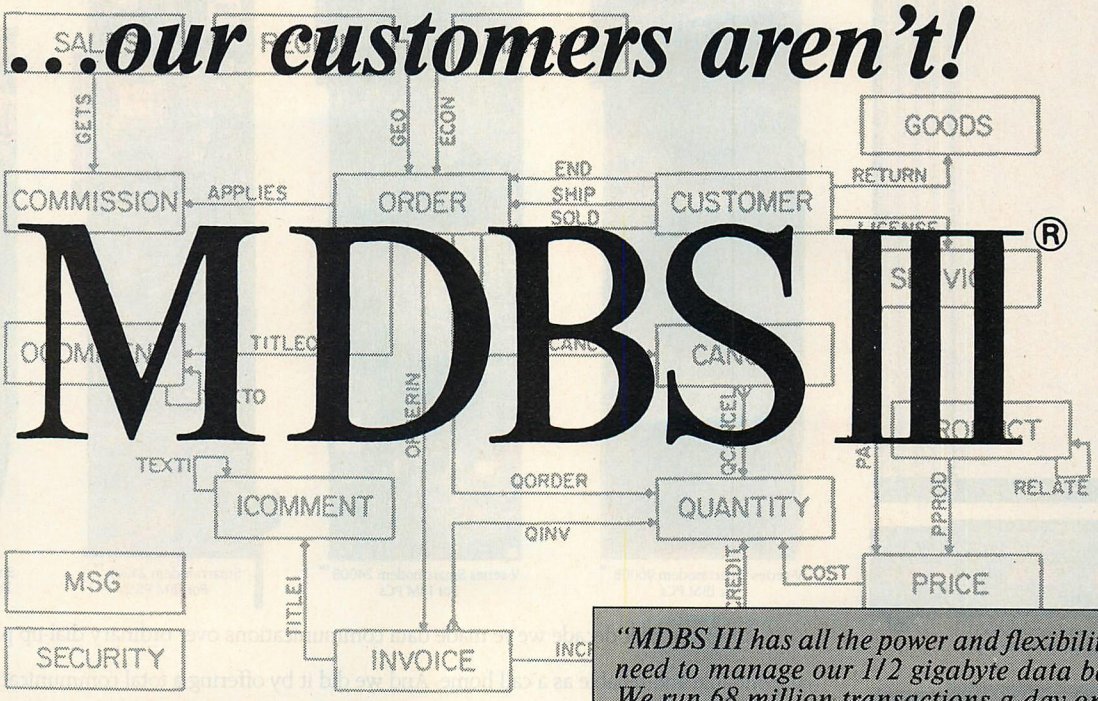

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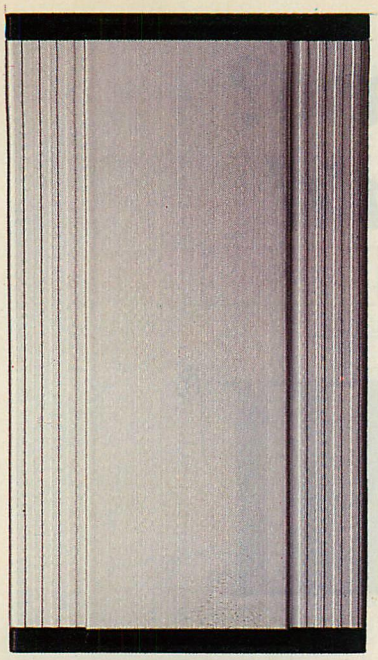

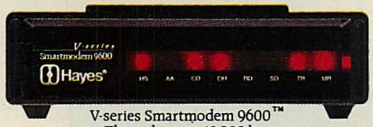

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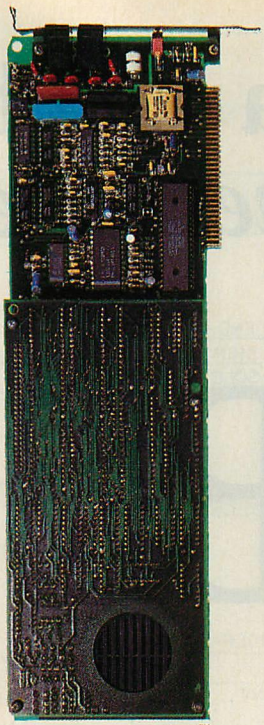

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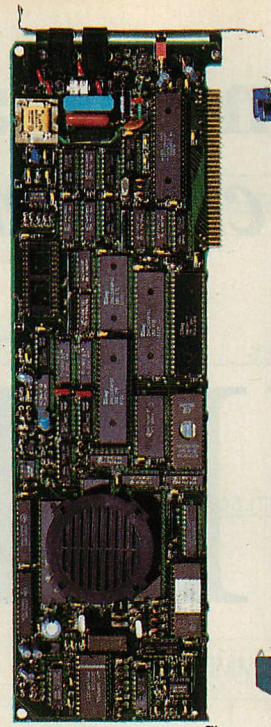

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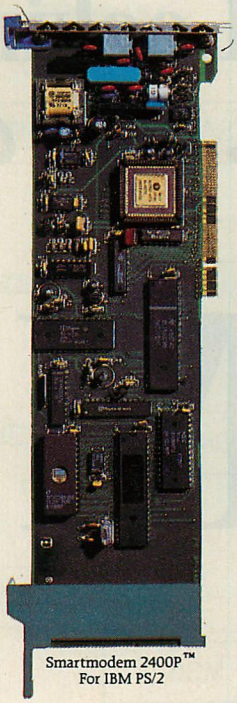

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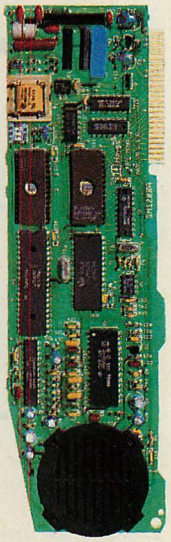

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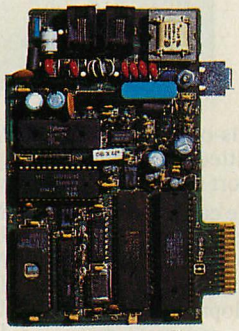

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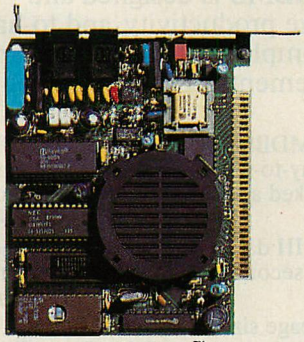

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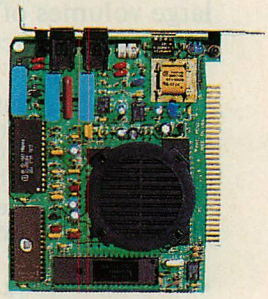

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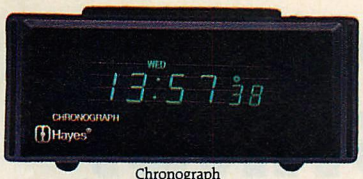

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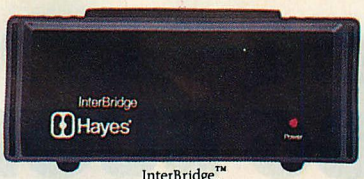

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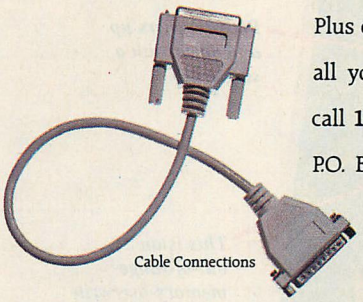

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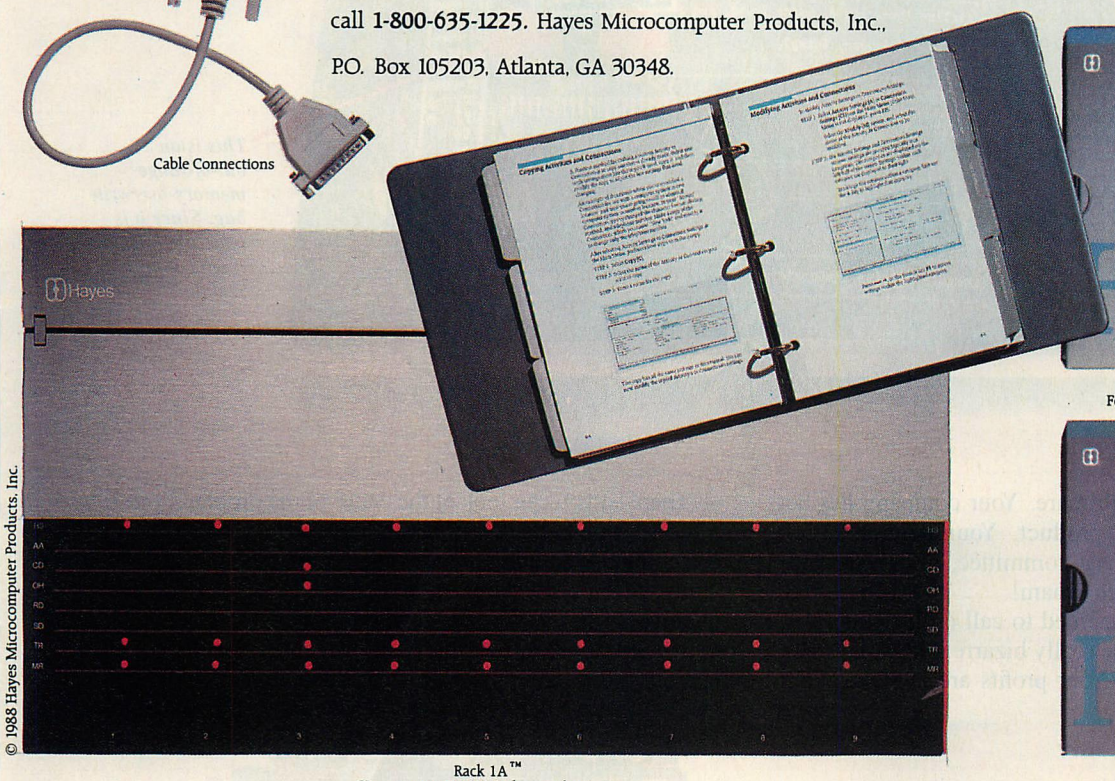

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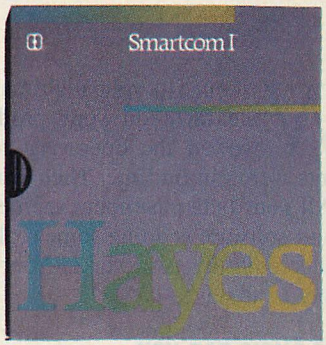

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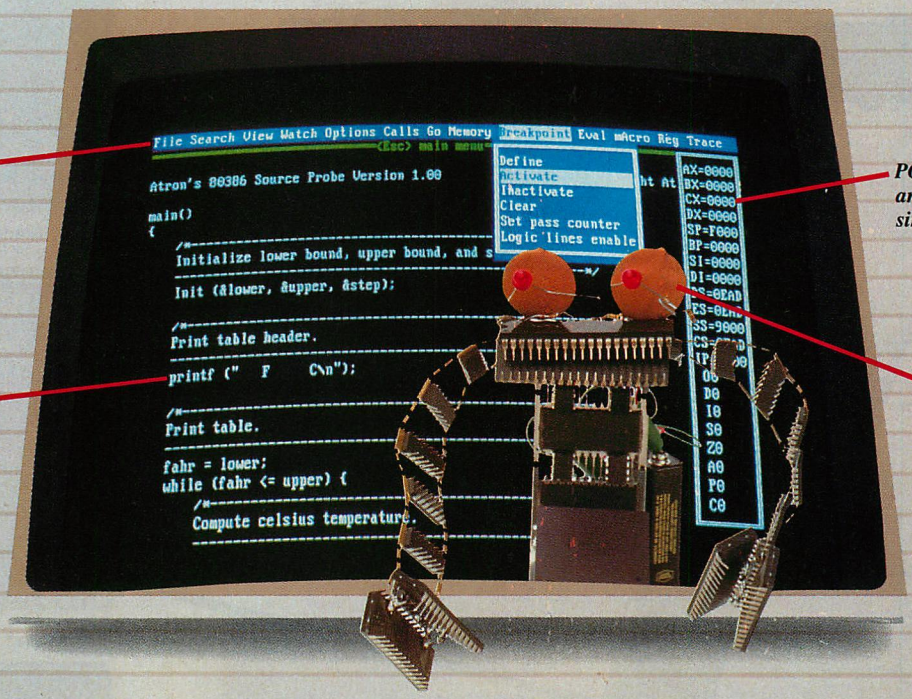
PROBE has source-level debugging to let you "C" your program.



POP registers up and down with a single key.

This is an out-of-range memory-overwrite bug. Since it is interrupt related, it only appears in real time.

Welcome to your nightmare. Your company has bet the farm on your product. Your demonstration wowed the operating committee, and beta shipments were out on time. Then wham!

All your beta customers seemed to call on the same day. "Your software is doing some really bizarre things," they say. Your credibility is at stake. Your profits are at stake. Your sanity is at stake.

THIS BUG'S FOR YOU

You rack your brain, trying to figure something out. Is it a random memory overwrite? Or worse, an overwrite to a stack-based local variable? Is it sequence dependent? Or worse, randomly caused by interrupts? Overwritten code? Undocumented "features" in the software you're linking to? And to top it off, your program is too big. The software debugger, your program and it's symbol table can't fit into memory at the same time. Opening a bicycle shop suddenly isn't such a bad idea.

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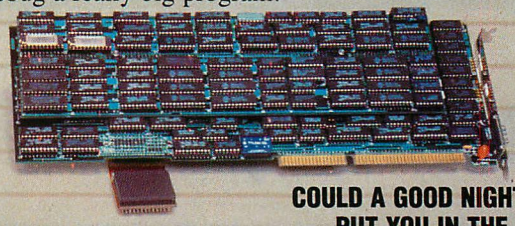
Announcing the 386 PROBE™ Bugbuster,*from Atron. Nine of the top-ten software developers sleep better at night because of Atron hardware-assisted debuggers. Because they can set real-time breakpoints which instantly detect memory reads and writes.

Now, with the 386 PROBE, you have the capability to set a *qualified breakpoint*, so the breakpoint triggers only if the events are coming from the wrong procedures. So you don't have to be halted by breakpoints from legitimate areas. You can even detect obscure, sequence-dependent problems by stopping a breakpoint only after a specific chain of events has occurred in a specific order.

Then, so you can look at the cause of the problem, the 386 PROBE automatically stores the last 2K cycles of program execution. Although other debuggers may *try* to do the same thing, Atron is the only company in the world to dequeue the pipelined trace data so you can easily understand it.

Finally, 386 PROBE's megabyte of hidden, write-protected memory stores your symbol table and debugger. So your bug can't roach the debugger. And so you have room enough to debug a really big program.



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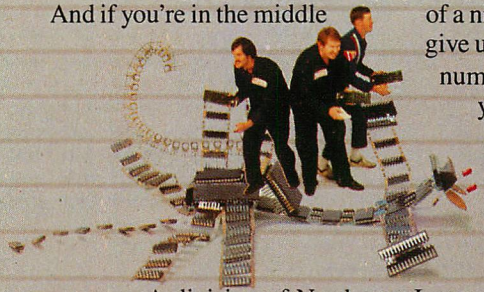

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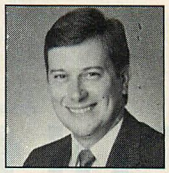


NEW DIRECTIONS

Looking through the Past

PC Tech Journal enters year number 6. □ Also, OS/2 and other Comdex goodies. □ Vopt and Vtools from Golden Bow Systems.

With this issue of *PC Tech Journal*, we celebrate our fifth birthday. These have been five years of astonishing growth and change in the computer industry. I signed on as editor with Ziff-Davis Publishing in January 1983, just 15 months after the introduction of the IBM PC; our July-August issue hit the newsstands 6 months later.

Fewer than 1 million PCs were installed at that time. Today, estimates say 20 million sit on desktops worldwide. The machines we use now have astounding power compared with the ones we thought were terrific back then. Times have indeed changed.

PC Tech Journal has changed, too. That is what I want to speak to you about this month, because I want you to understand why this magazine has evolved the way it has, and how you can expect it to evolve further. Our philosophy is a simple one, which may explain why it has worked so well for so long and why we expect to deliver valuable information to you well into the future.

OUR ROOTS

From the beginning, *PC Tech Journal*'s target audience consisted of systems developers and integrators who were responsible for desktop computing in their companies—in other words, an audience of people *paid* to know what our magazine would tell them. Insisting on computer professionals was the key ingredient of this philosophy. Today, there is no change in this concept; we seek exactly the same audience, and many of you have been with us from the beginning.

To make this work, we hired a technical staff of computer professionals. People who had been in precisely the same predicament as our audience understand exactly the kind of technical information that demanding professionals need. Included on *PC Tech Journal*'s staff are seven technically qualified editors with five master's degrees in computer science and more than 85 years of collective experience at the systems level. This expertise has been our secret ingredient; our technical editors really understand the material that we present to you, both from a theoretical view and in the context of the professional in the trenches.

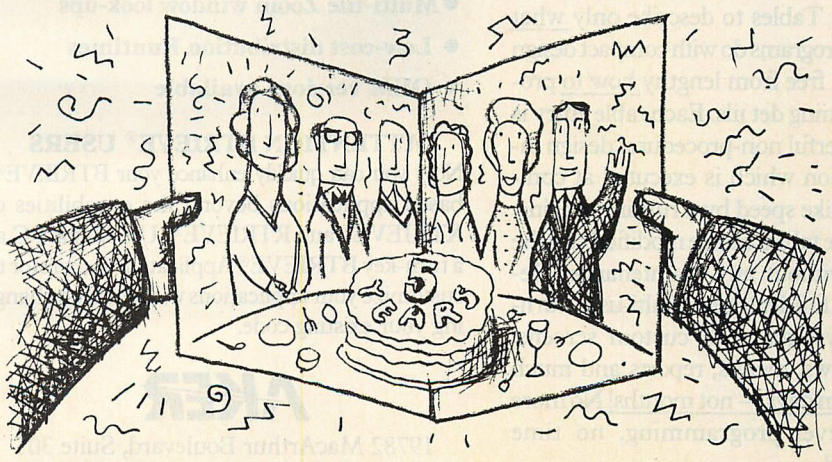
In addition to our technical staff, we hired a group of skilled writers and editors who are able to communicate our in-depth, often complex, information in a clear and concise form. These editors work as a team with the technical staff to deliver our material with the depth, objectivity, accuracy, and reliability you have always demanded. Our commitment to technical accuracy and the high value of the material we present to you is stronger today than it was when we launched the first issue. Again, no fundamental change.

If our fundamental philosophy and approach has not changed, why did I say that *PC Tech Journal* has changed? If not in philosophy, then how?

HIGH-TECH SURFING

The answer, of course, is wave after wave of technical change. The computer industry is not the same as it was five years ago, and neither are your needs as a systems professional.

- Five years ago you were still struggling with how to make the CGA run faster. *PC Tech Journal* published reference articles on the subject; we showed you how to get dirty INT 10s under your fingernails and greasy writes to video memory all over your hands. Why? You were certainly interested in how video worked, but many of you were writing applications for your businesses, and they had to be written quickly. When those programs you wrote appeared to be slower than Lotus 1-2-3, your end users complained and you went back to the source code to make your programs equally as compelling.
- Five years ago you were still struggling with how DOS worked and how you could build the many features that were not included in the operating system. Again, we helped you along with tips for performance and clues to the deep, dark secrets of the system.
- Five years ago we were all struggling to understand what compatibility meant. When *PC Tech Journal* began to cover IBM compatibles, we again established a point of reference for serious integrators. We helped you



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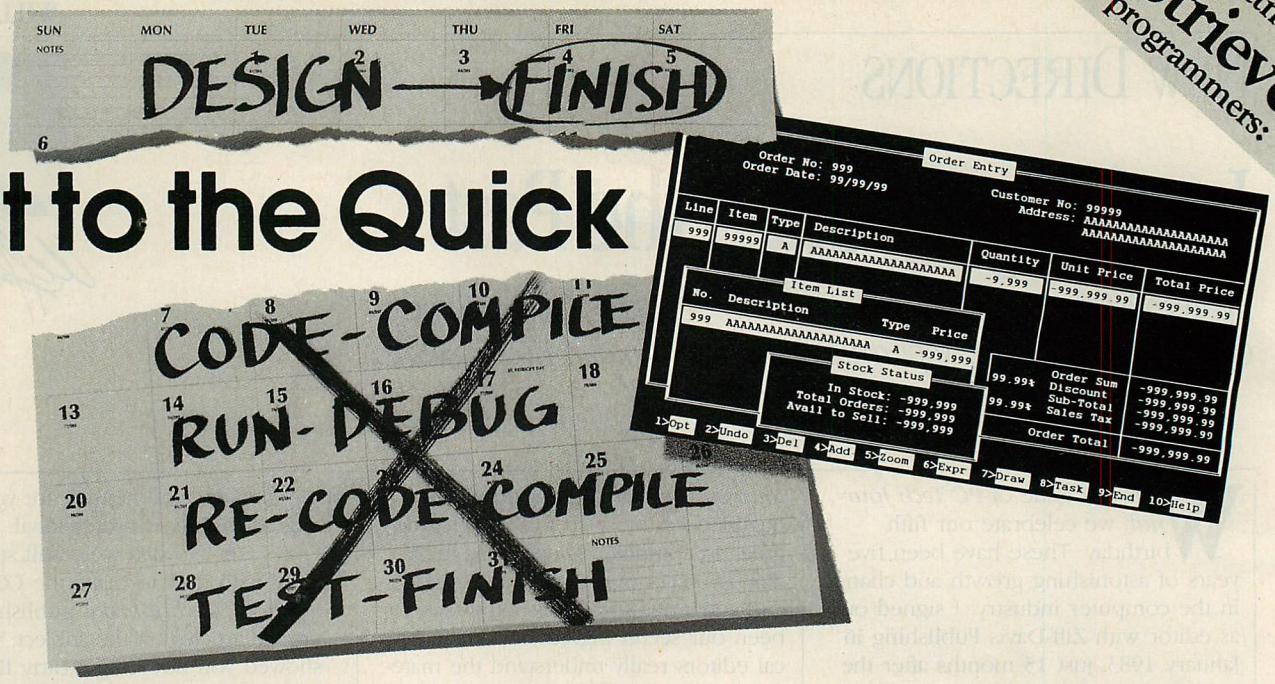

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plumb the depths of a new machine and gain confidence that it would mesh well with the desktop computers you already had installed.

For five years, *PC Tech Journal* has provided serious information to the developer and integrator just as the particular complexities became important issues to them. To do so, our technical staff has had to be on the leading edge of the hottest technological waves. That has given us the ability to cover timely issues with the confidence that we understand the subject matter thoroughly. The effort is necessary to give you the confidence that our material is not only useful, but also reliable.

We continue to ride the front of the technological wave. That is where we can best see what issues will be important to you and plan carefully for their coverage. And that is why we change; as time progresses, your requirements change.

Today we cover such complex topics as OS/2, the Presentation Manager, SQL, and networks. We have moved far away from the days when understanding the inner workings of INT 10 was critically important. Instead, we must learn and understand how to develop applications and build systems that are compliant with the myriad new rules forced upon us by layers of operating system functionality.

That is why I like to say that *PC Tech Journal* has risen by a level of abstraction. When criticized because we have not recently dwelled on INT 10, I reply that we have said everything that can be said about it—probably too much, if the truth be known. Our mandate today must be to explore the new methods that applications need to interface with the user—these methods are necessary because the user is demanding and expecting more.

When criticized because someone imagines we have become less technical, I reply that the complexity inherent in deploying a distributed application with distributed data makes writing fast video routines look like a cakewalk, that the details are just as technical and just as intimidating. They are also far more important, with wide-ranging, long-term implications.

If these new, highly technical developments are a challenge for you, then they are equally so for us. You can rest assured that we will continue to make the maximum effort to explain difficult issues to you. Where desktop computing is concerned, *PC Tech Journal* will always bring you the most detailed, accurate, and reliable systems information you can find anywhere.

OS/2 SPLASH AT COMDEX

If anything was big news at Comdex/Spring, it was the smooth and sophisticated way IBM and Microsoft presented the arrival of applications for OS/2. How impressive was it? The OS/2 booth was just as huge as IBM's own booth, which was enormous. Inside the booth, which was clearly identified with a large OS/2 logo as well as the IBM and Microsoft logos, were almost 70 vendors demonstrating their OS/2 wares. IBM pitched its Extended Edition and gave demos. Information desks handed out a directory of OS/2 applications; the book highlighted some 300 products and gave estimates of their availability dates.

But wait, there's more! IBM and Microsoft jointly sponsored a no-announcements press breakfast, at which IBM's Bill Lowe and Microsoft's Bill Gates took questions about OS/2. Although there were no revelations and no announcements, both Bills were responsive and answered candidly. Gates even alluded to subsequent versions of OS/2 that will more fully exploit the 32-bit capabilities of the 80386 processor, an area of some problem for the moment.

Was I impressed? The honest answer is yes and no. I was certainly impressed with the effort both companies put forth to get the message out, and I was impressed with the progress many vendors have made with their OS/2 products. In that sense, the booth was a good way to get an interim report card. On the other hand, all is not what it seems.

Of the 300 products under development, about 52 are said to be "ready." This might lead you to believe that 52 products are available, but a more accurate assessment is fewer than 10. Many of the 52 are not yet shipping. This fuzziness is intentional, designed to give potential integrators the notion that OS/2 is closer to fruition than it really is. Remember that the Presentation Manager is not even available for the end user, so members of the elite 52 that require it are certainly not imminent.

I worry whenever someone hands me a book of supported software applications. I interpret this as a move of desperation—more hype than substance. Such books are valuable, but when have you ever seen either IBM

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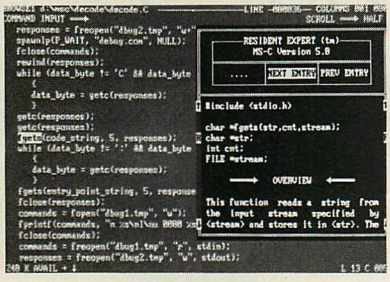

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or Microsoft publish a directory of DOS applications? The answer is never, because no one needed any convincing. The potential buyers of OS/2, for all their interest and examination, are still in the "show me" stage, and the directory is an attempt to do that. When OS/2 finally catches on, you are not very likely ever to see a directory like this again.

Everyone is glad that progress has been made with the important OS/2 applications of the future. I am just sorry that the current environment is filled with hype. Believe me, when the applications for OS/2 are ready, you will hear about it from every conceivable source—over and over. That's a moment I really look forward to.

Apart from the OS/2 displays, Comdex was a boring show this year. That's the way it will be for the foreseeable future for the simple reason that each new increment in technology is not quite as big as the last. Yes, 25-MHz 386 machines are exciting, but a tad less so than the 20-MHz ones were. Nonetheless, here are comments about a few points of interest.

One 25-MHz machine did catch my attention: the ALR FlexCache 25386 model. Unlike other 386 machines, this one does not use the Intel 82385 cache controller. Instead, ALR has built in its own caching scheme, which company officials claim is superior. Another vendor has also eschewed the 82385; Everex, in its current 20-MHz 386 and new 25-MHz model, uses a design developed by company founder and president Steve Hui. These machines represent yet another architectural departure in the 386 world—and yet another factor to consider when evaluating equipment such as this.

A new product has appeared on the data management market. "What, another one?", you might ask, but D the data language is an interesting and promising product (see Tech Releases, this issue, p. 43). *PC Tech Journal* saw D in action for the first time at a private demonstration during Comdex. Its claim to fame is not only superior performance, but something even more important: sharply reduced development time, according to its manufacturer, Caltex. Indeed, the language is quite expressive. Compared against code written to perform the same task in a variety of other languages, the D code is concise and compact.

To be sure, this is a product with some rough edges. At first glance, however, D the data language looks like a product worth considering if you are fed up with the amount of time needed to build your applications.

I was surprised to see another entrant in the shell game. Catalonia Software is offering a product called OVERDOS, which is similar in style to Microsoft Windows. The OVERDOS.SYSTEM program offers less than Windows in some ways, but it has many direct manipulation capabilities that Windows lacks. For example, you can grab a subdirectory with the mouse and move it (and all its subordinate files) to a new location on the directory tree. This particular operation is a pain under DOS or Windows and only partially supported under the OS/2 Presentation Manager. That example caught my eye; after I have had more time to experiment, I will report again in these pages. In the meantime, Catalonia has an introductory price of $49.95 for the program, so it is inexpensive to try. Catalonia's address is 12930 Saratoga Avenue, B-1, Saratoga, CA 95070-9924. The phone number is 408/446-2666.

I also ran across a new product called the PubTech File Organizer from Publishing Technologies Inc. in Austin, Texas (512/246-2835). PTO (my acronym—I hate the name) is a Windows application that provides another visual layer above the MS-DOS executive. The icon-based interface allows the user to perform a higher number of direct manipulations than Windows or even the OS/2 Presentation Manager (see last month's column for more information on that). For example, a file can be moved by clicking the mouse on its icon and dragging it, a la Macintosh. PTO's price is $145; in a bundle with the Logitech Mouse, it is $195.

Plus Development, which brought us the Hardcard and kicked off the disk-on-a-board business, is at it again with a new product called the Plus Passport, a 20MB or 40MB removable hard-disk drive that mounts in a standard 5.25-inch half-height space (external chassis optional). Plus did not get there first, however; Tandon announced its Personal Data Pac removable drive at Comdex/Spring '87 and has been shipping it for some time. Nonetheless, Plus has a name and a reputation for reliability (this new unit is specified for 60,000 MTBF), so I expect its announcement to spur interest in both the Plus Passport series as well as the Tandon equipment.

Do check the Plus Passport carefully; the specifications sheet hedged on performance with the new term "ef-

C++

FROM ZORTECH INC.

The change to a pure language

Now, C programmers can move over to C++ with Zortech C++ – the world's first 'true' C++ compiler for MS-DOS machines.

Zortech C++ is a 'true' compiler and fully conforms to Bjarne Stroustrup's specification as outlined in his book 'The C++ Programming Language'.

Previous implementations of C++ were actually 'translators' – only able to translate C++ source code into C. Of course, this was unacceptable due to the long translating and compiling times.

Now, C++ comes of age with the introduction of the world's first true C++ compiler – from Zortech!

■ *Object Oriented Programming*

C++ is to C what Modula 2 is to Pascal. C++ brings 'classes' to C, so you can create separate modules that contain their own data and data-related operations. These 'classes' then become new types that can in turn be used to create further modules – this allows you to practically create your own language.

■ *ANSI C Superset*

You don't have to throw away your existing C programs – C++ is a superset of ANSI C. Now, you can take your Microsoft C or Turbo C compatible programs and easily migrate to C++ to take full advantage of the new C++ features.

■ *'Codeview' Compatible*

Zortech C++ is compatible with 'Codeview' – Microsoft's industry standard source code debugger.

■ *Improved Program Structure*

As stated in 'The C++ Programming Language', by using C++ "It would not be unreasonable for a single person to cope with 25,000 lines of code".

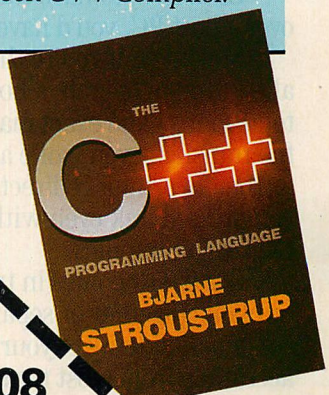
■ *Other benefits*

Here's just a few: Operator overloading, overloading function names, default arguments to functions and better type checking.

CIRCLE NO. 150 ON READER SERVICE CARD

ESSENTIAL READING!

This 325 page book 'The C++ Programming Language' by Bjarne Stroustrup contains the original definition of C++. All the examples shown in this book have been successfully compiled and executed with the Zortech C++ Compiler.



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REMOTE² is packed with features users have asked for. A choice of three distinct automatic and manual answering modes. Directory-to-directory file transfers using a half-screen display of host files. Proprietary file transfer protocol with redundant file skipping and partial file recovery (other popular protocols also supported). A "Phone Book" that facilitates one-entry calls from listings of names, numbers, and passwords. Host call-back capability. Integrated, context-sensitive help system. LAN access. Mainframe access to an IBM host with IRMA. And more.

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fective access time," which is stated as 28 ms. A footnote reveals that " . . . data throughput is similar to hard disks with 28-ms average seek times."

GOLDEN UTILITIES

The venerable Norton Utilities has served so well for so long that it is hard to imagine how any other utilities package could compete and obtain reasonable market share. I have recently discovered two packages that should be well-received by professional developers: Vopt and Vtools from Golden Bow Systems (2870 Fifth Avenue, Suite 201, San Diego, CA 92103, 619/298-9349), which also offers a number of other utility packages. Vopt and Vtools each have one compelling program accompanied by a group of other utilities that vary in usefulness.

The star of the Vopt package is the Vopt program itself. Vopt reorganizes a hard disk (or diskette, for that matter) by eliminating fragmentation. The result is a disk on which each file resides in contiguous sectors, making just about every type of file access, including program loading, much faster because unnecessary seeks of the disk heads are eliminated. This is very similar to the Speed Disk program that comes with the Norton Utilities Advanced Edition, but it differs in a significant way. Unlike Speed Disk, Vopt does not try to move all the files to the front of the disk.

The effect is that Vopt runs much more quickly than Speed Disk, and that means Vopt can be run every time a system is booted, with minimal overhead. Rather than having a system that slowly degrades over time, you can have Vopt optimize the hard disk once a day. After the first time Vopt runs, the overhead is minor; in my experience with an IBM PC/AT Model 339 and a Compaq Deskpro 386/20, Vopt never took more than 20 seconds to run, even on a disk that was purposely fragmented as a test.

This is the kind of program that can really make a difference to someone who demands the best possible performance from a system. Programmers will find it particularly helpful; the editing and compiling cycle usually involves the creation and deletion of many files, exactly the kind of activity that causes fragmentation.

The standout in the Vtools package is a program called Vref, which takes as arguments the names of two directories (or diskettes) and compares them. It then displays a list of files, showing which were the same in both directories, which were different and how they differed (size or date), and which were found in one directory but not the other. More-current files can be copied to the desired directory as an update, but, as a protection measure, Vref never overwrites a file with a more recent date.

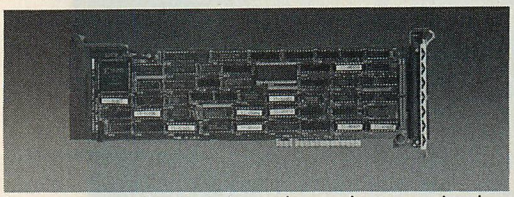
This program is so useful that I have often threatened to write it myself; I am glad somebody finally saved me the trouble. Vref is marred by being a bit rough around the edges; I would hope to see a clearer presentation of the comparison in future versions, along with better options for choosing which files should be copied. Better human factors would make it even more desirable.

These two packages from Golden Bow are really worth the price ($59.95 for Vopt and $49.95 for Vtools). All the other utilities included in the packages are just icing on the cake because the Vopt and Vref programs are worth the purchase price by themselves.

Will Fastie is the editorial director and founding editor of PC Tech Journal.

FAME™

...The first 9-track magnetic tape controller for IBM's Personal System/2 Micro Channel computers. Our LEO PC tape controller made us famous... Now, for your PS/2, we bring you "FAME" Fast Access Media Exchange.



From the people who brought you the first 9-track tape subsystem for the IBM-PC comes the first 9-track magnetic tape controller and subsystem for the Personal System/2. With the new PS/2's high performance capabilities, you need a high performance magnetic tape controller, whether your application is moving data between computer systems (including PC's to PS/2's), backing up disk and/or file servers or processing tapes from telephone switching systems, FAME can provide the fast access you've been looking for. IDT manufactures complete subsystems for both PC and PS/2 computers that include a tape drive, controller, cables, along with extensive software and documentation offering you the only true single vendor solution. IDT also maintains a full-time customer service staff providing the highest level of customer support.

IBM's Personal System/2

IDT's Model TD-1012/FAME Tape Subsystem

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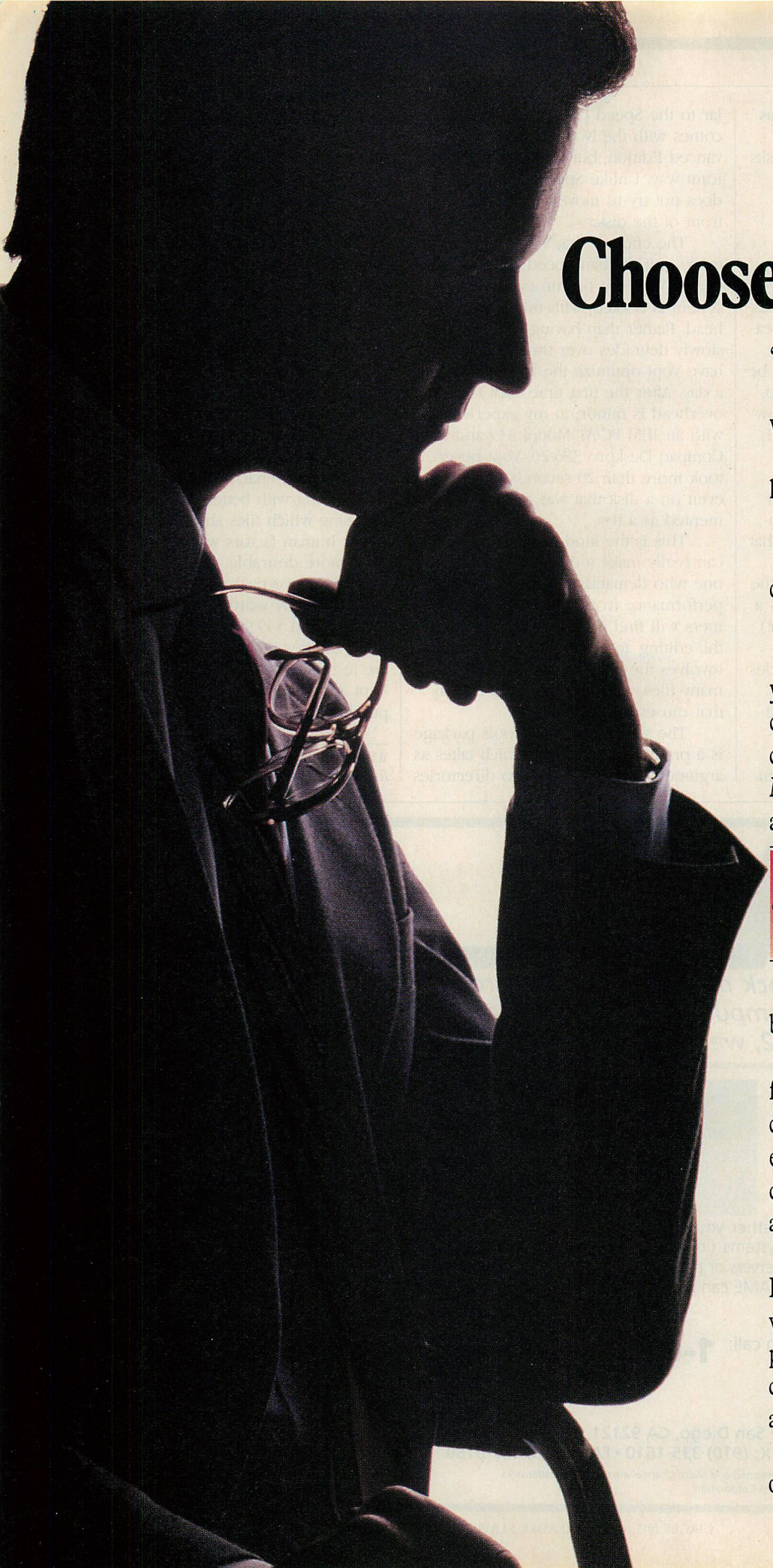


Choose the Wrong

"I just assumed..."

These are the three most deadly words in business.

When others hear them, they know what happened.

Someone didn't do his homework.

Someone didn't ask the right questions.

Someone didn't think.

The next operating system you choose will have far-reaching consequences...in terms of cost, compatibility, and connectivity. Make sure your recommendations aren't based on false assumptions.

"Tell me again why our next operating system will cost over $1,000 per computer."

When they tell you that OS/2 will be a low-cost upgrade, don't believe it.

Computerworld's March 7, 1988, front-page story stated that OS/2 could cost "nearly $5,000 in additional expenses" for each IBM PC AT...to cover the costs of memory expansion and a new display.

"Even if you just bought an IBM Personal System/2 Model 50 last week," the report continued, "you are probably looking at extensive upgrade costs..." $1,750 for more memory, alone.

Plus, you'll need to add the costs of new applications software, the costs

Operating System...And You'll Pay.

of training, and the costs of the system.

All in all, a very expensive upgrade.

"How can you say this operating system is compatible...when half our computers can't even run it."

Take a look around at the mix of PCs your company uses.

Think one version of OS/2 can be used as a company standard?

Think again.

Because each brand of 80286 or 80386 PCs or PS/2s needs its own machine-specific version. And each version has its own set of hardware and software compatibilities.

8088-PCs are totally out of the picture, and PC-DOS programs don't run while you're interacting with an OS/2 application.

"So you're telling me that to play it safe, we should use the operating system's network... or use none at all."

Open architecture is what built the business PC industry...because it enables you to mix and match the best software with the best hardware for your specific needs.

Which makes you wonder just how smart it is to install an operating system designed for a specific network... that may or may not be best for you. That may or may not be compatible with the networks you already have.

Our competition wants you to buy it all from them.

We give you a choice.

So we're compatible with the networking standard: Novell.

We take advantage of the fastest software-driven network: LANLink 5X.™

And we work with the standard in micro-to-mainframe connectivity: Irma by DCA.

"What's this I've heard about operating systems designed for multi-user work groups?"

In short, they're the way of the future.

Because they address the very same needs that most concern you.

Like cost, compatibility, and connectivity.

PC-MOS is a unique DOS-compatible, multi-user operating system. It lets departments use inexpensive dumb terminals (or 8088-PCs running terminal emulation software) in combination with host computers.

Because it's multi-user, you can share a PC's data, programs, memory, and processing power with workstations costing under $500, each.

"If PC-MOS can save us over $1,000 per user, why aren't we using it?"

Good question.

Because with PC-MOS, you get an operating system that lets you share your computers' resources instead of forcing you to spend up to $5,000 per user upgrade.

PC-MOS was designed to be an operating system standard for the mix of 80286 and 80386 PCs in your company. So you don't have to worry about varying levels of compatibility among your PCs.

It's an operating system that provides compatibility with the hardware and software you have. And it provides a migration path to future applications which will take advantage of the 80386 processor's 32-bit mode.

PC-MOS is available for both 80286 and 80386 PCs and PS/2s.

It comes in single-user, five-user, and 25-user versions, starting at $195, all of which include a money-back guarantee.

For complete details, call The Software Link at 1-800/451-LINK.

PC-MOS/286™, PC-MOS/386™, and LANLink 5X™ are trademarks of The Software Link, Inc. PC AT, PS/2, Personal System/2, PC-DOS, & OS/2 are trademarks of IBM Corp. IRMA is a trademark of DCA, Inc. Prices and technical specifications subject to change. Copyright ©1988. All Rights Reserved.

CIRCLE NO. 196 ON READER SERVICE CARD

TECH RELEASES

The latest in hardware, software, and technology for systems developers and integrators

Tandy 5000 MC 80386-based microcomputer

SYSTEMS

A 20-MHz 80386-based microcomputer with a Micro Channel-compatible bus is offered by **Tandy Corporation**. The **Tandy 5000 MC** has VGA capability on the main logic board that provides CGA, EGA, MCGA, and VGA compatibility. The Intel 82385 cache memory controller with 32KB of static RAM memory allows the Tandy 5000 MC to achieve zero-wait-state performance. The standard configuration includes 2MB of DRAM, using 256KB single in-line memory module (SIMM) devices; an additional 2MB can be added to a dedicated memory board using 256KB SIMMs, and a maximum system memory of 16MB can be obtained using 1MB SIMMs.

The Tandy 5000 MC has five Micro Channel-compatible expansion slots and two 32-bit proprietary memory-expansion slots. The base configuration includes a 1.44MB 3.5-inch diskette drive with room for three additional half-height slots, support for a 20-MHz 80387, serial and parallel ports, a dedicated mouse port, realtime battery backup clock, and a 101-key keyboard and keylock. One standard configuration includes a Micro Channel-type ST-506 hard-drive controller and an 84MB 3.5-inch, 15-ms hard-disk drive. Base system, $4,999; with 40MB hard-drive, $6,499; with 84MB hard-drive and ST-506 controller, $6,999.

Tandy Corporation, 1800 One Tandy Center, Fort Worth, TX 76102; 817/390-3700

CIRCLE 303 ON READER SERVICE CARD

Combining both UNIX and DOS capabilities, the **Sun386i** workstation family from **Sun Microsystems Inc.** incorporates the Intel 80386 32-bit CPU. The standard Sun386i workstation includes an 80387, 4MB of memory, an Ethernet controller, AT/XT bus with four slots for PC-style option cards, SCSI controller, RS-232 serial and Centronics ports, a 1.44MB 3.5-inch diskette drive, optional 91MB to 327MB hard-disk drives, a keyboard, and mouse. The workstation comes in 20- or 25-MHz versions. Color monitors are available in 19 or 16 inches with 1,152-by-900 pixel resolution, or 14 inches with 1,024-by-768 pixel resolution; monochrome choices are 19- or 15-inch monitors with 1,152-by-900 pixel resolution.

To ensure maximum DOS compatibility, Sun has licensed VP/ix and ROM BIOS technology from Phoenix Technologies. The **Sun386i DOS Window** allows simultaneous operation of multiple DOS applications. Users can copy and paste text between UNIX and DOS windows and share files and data between UNIX and DOS applications. Sun386i includes an enhanced version of Sun Microsystem's SunOS. More than 75 third-party software vendors, OEMs, and end users have implemented UNIX software applications and hardware products for the Sun386i.

Floor-standing Sun386i with monitor choices

Depending on the choice of monitor and hard-disk options, the prices range from $7,990 to $13,990.

Sun Microsystems Inc., 2550 Garcia Avenue, Mountain View, CA 94043; 800/821-4643; 800/821-4642

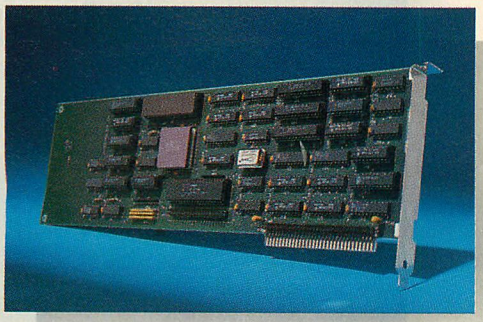
CIRCLE 301 ON READER SERVICE CARD

Three personal computer systems have been introduced by **Dell Computer Corporation** (formerly PC's Limited). The 20-MHz 80386-based **Dell System 310** has an Intel 82385 cache memory controller, 1MB of memory (expandable to 16MB), eight expansion slots, two serial ports, one parallel port, and an enhanced keyboard. Options include 40MB, 90MB, 150MB or 322MB hard-disk drives; EGA, VGA monochrome, VGA color, or VGA color-plus monitors; and 3.5- or 5.25-inch diskette drives. $3,599 to $7,399.

The 20-MHz 80286-based **Dell System 220** features integration of a VGA adapter, diskette-drive controller, one parallel and two serial ports, a hard-disk interface, and 1MB of RAM (expandable to 8MB on the system board). It has an enhanced keyboard, a 1.44MB 3.5-inch diskette drive, one parallel and two serial ports, and three 16-bit expansion slots. Options include a 40MB or 100MB hard-disk drive and VGA monochrome, VGA color, or VGA color-plus monitors. $1,799 to $3,699.

The 9.54-MHz 8088-based **Dell System 100** comes with 640KB of RAM, one 720KB 3.5-inch diskette drive, 8087 support, one serial and one parallel port, two full-size expansion slots, and an 84-key keyboard. Options include a second diskette drive or a 20MB hard-disk drive, and monochrome, CGA color, VGA monochrome, or VGA color monitors. $799 to $1,699.

Dell has also announced that two personal computers based on IBM's Micro Channel Architecture will be available in the fourth quarter of 1988. The **System 400**, a 20-MHz 286-based



286 Express/30-12 accelerator board from PC Technologies

PFX1200 external 5.25-inch diskette drive from Procom

machine comparable to IBM's PS/2 Model 60, will have 1MB of memory (expandable to 16MB) and a 1.44MB 3.5-inch diskette drive with a disk-caching utility. The **System 500**, a 20-MHz 386-based computer comparable to IBM's PS/2 Model 80, will have hard-disk options of 40MB, 90MB, 150MB, 322MB, and 610MB. Contact the company directly for price information. *Dell Computer Corporation, 9505 Arboretum Blvd., Austin, TX 78859-7299; 512/338-4400*

CIRCLE 302 ON READER SERVICE CARD

TECHNOLOGY

The first complete set of **ROM BIOS products** for core logic and peripheral controllers used to manufacture systems equivalent to the IBM PS/2 Models 50 and 60 has been developed jointly by **Faraday Electronics**, a wholly owned subsidiary of **Western Digital**

Core logic chip set from Faraday and Phoenix

Corporation, and **Phoenix Technologies Ltd.** The ROM BIOS product line supports Western Digital's integrated system, core logic, mass storage, video, printer, and communications controller products.

The ROM BIOS, which is incorporated in the **FE5400** core logic four-chip chip set, will be marketed and sold to board-level integrated systems customers by Western Digital, and to OEM chip customers by Phoenix Technologies, which will also maintain the BIOS code. FE5400 chip set, in 100-unit OEM quantities, $124.

Western Digital also has announced the release of the **Model 50/60 evaluation kit**, which consists of an Intel 80286 microprocessor and an optional 80287 coprocessor, the FE5400 core logic four-chip chip set, a BIOS, a Western Digital WD57C65 diskette-drive controller, a Western Digital 16C552 dual asynchronous communications element communications controller, and a Western Digital/Paradise Systems PVGA controller. The evaluation kit is built on a Model 60 form factor and allows evaluation of components, BIOS, and core logic in a systems environment. $2,500.
Faraday Electronics, 749 N. Mary Avenue, Sunnyvale, CA 94086; 408/749-1900

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Phoenix Technologies Ltd., 320 Norwood Park S, Norwood, MA 02062; 617/769-7020

CIRCLE 305 ON READER SERVICE CARD

Western Digital Corporation, 2445 McCabe Way, Irvine, CA 92714; 714/474-2033

CIRCLE 306 ON READER SERVICE CARD

PERIPHERALS

An external 1.2MB 5.25-inch diskette drive for use with all IBM PS/2 models has been announced by **Procom Technology Inc.** The **PFX1200** features a data-transfer rate as fast as 500 Kbps, access time of 3 ms, and a mean-time-between-failure rate of 12,000 hours. It has its own internal controller and reads, writes, and formats both 360KB and 1.2MB diskettes. The PFX1200 allows users to convert data from the 5.25-inch to 3.5-inch format and to share information between PS/2s and earlier generations of PCs. $450.
Procom Technology Inc., 3100 Airway Drive, Suite 128, Costa Mesa, CA 92626; 714/549-9449

CIRCLE 317 ON READER SERVICE CARD

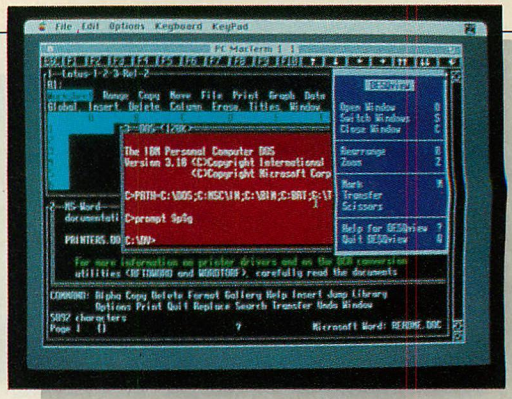
PC Technologies Inc. has introduced 12- and 16-MHz versions of a full-slot 80286 accelerator board for the IBM PS/2 Model 30 and other 8086-based microcomputers. The **286 EXPRESS/30-12** and the **286 EXPRESS/30-16** feature software-programmable system configuration and keyboard-selectable 80286/8086 processing with 16KB of cache memory. They also support use of an optional 8087 in the system and an optional 80287 on the accelerator board. EXPRESS/30-12, $575; EXPRESS/30-16, $695.
PC Technologies Inc., 704 Airport Blvd., Ann Arbor, MI 48108; 800/821-3086; 313/996-9690

CIRCLE 315 ON READER SERVICE CARD

A VGA board that features Video RAM (VRAM) has been released by **Video Seven Inc.** The **V-RAM VGA** graphics board is compatible with the IBM PS/2 VGA display adapter and offers IBM's high-bandwidth monochrome mode, which enables V-RAM VGA to double the frequency of CPU memory access. V-RAM VGA provides BIOS compatibility with the EGA standard and downward compatibility with CGA, MDA, and Hercules. Designed to operate at 65 MHz, V-RAM VGA supports both monochrome and color graphics and text on displays such as the PS/2 analog monitors, the NEC MultiSync, and Sony MultiScan monitors.

With on-board memory of 256KB VRAM, V-RAM offers colors and resolutions ranging from 4 colors at 1,024-by-768 pixels to 256 colors at 640-by-400 pixels. With 512KB on-board VRAM (optional 256KB VRAM), it can provide 16 colors at 1,024-by-768 pixel resolu-

10NET LAN software from 10NET Communications

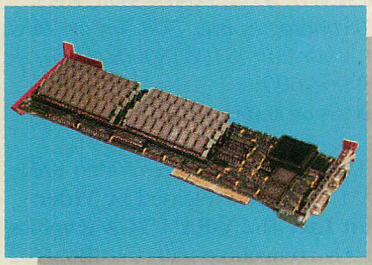


PC MACTERM screen from DMA

tion to 256 colors at 640-by-480 pixel resolution. Video Seven will bundle software drivers to support Microsoft Windows and Windows/386, as well as Autodesk's AutoCAD and AutoShade applications at these resolutions. $799.
Video Seven Inc., 46335 Landing Parkway, Fremont, CA 94538; 800/238-0101; 800/962-5700; 415/656-7800

CIRCLE 314 ON READER SERVICE CARD

Two memory products available from **Orchid Technology** provide PS/2 users with the additional memory they need to run extended memory and OS/2 and EMS 4.0 applications. **RamQuest Extra** is a multifunction board for the IBM PS/2 Models 50, 60, and 80. It provides as much as 8MB of memory



RamQuest Extra from Orchid Technology

using 256KB or 1MB single in-line memory modules (SIMMs) and has two serial ports. **RamQuest II** has 1MB of memory that can be upgraded to 2MB using 256KB DIP chips. Both memory boards can be installed in less than five minutes. RamQuest Extra: 0KB, $599; 512KB, $899; 1MB, $1,199. 1MB RamQuest II, $849.
Orchid Technology, 45365 Northport Loop West, Fremont, CA 94538; 415/683-0300

CIRCLE 316 ON READER SERVICE CARD

A Micro Channel-compatible memory board for IBM PS/2 Models 50 and 60 is being shipped by **Boca Research Inc.** The **BOCARAM 50/60** is available in 1MB and 2MB configurations (expandable to 4MB with 1-megabit, 120-ns DIP RAM chips. It includes software for the Lotus/Intel/Microsoft EMS emulation, a menu-driven installation program, and a diagnostic package. 0KB, $295; 1MB, $645; 2MB, $995; 4MB, $1,695.
Boca Research Inc., 6401 Congress Avenue, Boca Raton, FL 33487; 305/997-6227

CIRCLE 318 ON READER SERVICE CARD

CONNECTIONS

10NET Communications, a division of Digital Communications Associates Inc. (DCA), has unbundled its **10NET LAN** software for use on the IBM Token-Ring and PC Network boards. 10NET LAN adheres to NETBIOS standards and supports server message block (SMB) protocol suites. Utilities included are mail, calendar, spooling, user-to-user communications, broadcast communications, and remote job submission. Servers can be dedicated or nondedicated, and each PC on the network can share data and peripherals. Per node, $395; bundled with software documentation, tap box, cable, and interface board, $695 per node.
10NET Communications, 7016 Corporate Way, Dayton, OH 45459-4223; 513/433-2238

CIRCLE 308 ON READER SERVICE CARD

PCs and Macintoshes have been brought closer by **Dynamic Microprocessor Associates Inc.**'s introduction of **PC MACTERM**. The remote-computing software package works with DMA's PCANYWHERE III product to let any user run a PC from a Macintosh via a modem, direct cable connection, or an AppleTalk network. PC MACTERM runs on the Macintosh, while PCANYWHERE runs on the PC. The product also allows a Macintosh user to run peripherals attached to the PC and all internal boards (such as IRMA and network adapter boards). $99.
Dynamic Microprocessor Associates Inc., 60 E. 42nd Street, New York, NY 10165; 212/687-7115

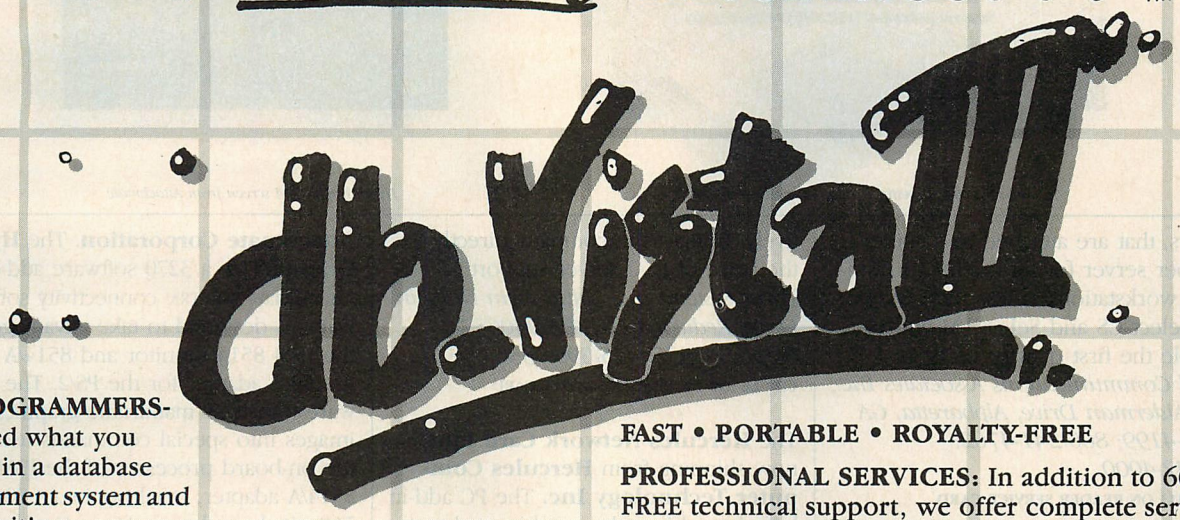
CIRCLE 311 ON READER SERVICE CARD

Digital Communications Associates Inc. (DCA) has developed the **DCA Select OS/2 Communications Server** (Select CS), a product that will provide end users with PC-to-mainframe SNA connectivity and PC-to-asynchronous host connectivity in OS/2-based LANs. With Select CS, DOS and OS/2 users on an OS/2 LAN can have IRMA-type PC-to-IBM mainframe access and Crosstalk-type PC-to-non-IBM mainframe access. Select CS includes both DOS and OS/2 client and stand-alone workstations; each workstation type provides the user with IBM 3270 terminal and printer emulation, bidirectional file transfer, and API support. Its DOS workstations are fully compatible with DCA's IRMALAN products.

Select CS implements advanced program-to-program communication (APPC), logical unit 6.2, and physical unit 2.1 for OS/2 LAN users. It supports multiple concurrent connection types within one server, including workstation access through an SDLC, DFT, or 802.22 Token-Ring gateway connected to stand-alone workstations. Select CS also supports a host-to-LAN print spooler and an asynchronous gateway to non-IBM hosts. The price per server for an entry-level server (supports as many as eight concurrent users, five sessions per user, and all gateway types) is less than $3,000.

DCA also announced the **DCA Select MS OS/2 LAN Manager** (Select LM), a product based upon Microsoft's OS/2 LAN Manager, which has been licensed by DCA. Select LM will allow both DOS and OS/2 workstations to share resources, such as hard disks and

Fast database development system with SQL-based db_QUERY and Lotus 123 interface. . . ™



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db_VISTA III™ is the database development system for programmers who want powerful, high performance DBMS capabilities ... and in any environment. Based on the network database model and the B-tree indexing method, db_VISTA III gives you the most powerful and efficient system for data organization and access. From simple file management to complex database structures with millions of records. db_VISTA III runs on most computers and operating systems like MS-DOS, UNIX, VAX/VMS and OS/2. It's written in C and the complete source code is available, so your application performance and portability are guaranteed! With db_VISTA III you can build applications for single-user microcomputers to multi-user LANs, up to minis and even mainframes.

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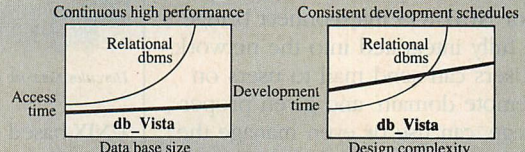
HOW TO ORDER: Call us; we'll help determine your needs and get you started. Add components as you need them. Ask about the new Lotus interface. . .Call today!

The db_Vista Difference



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1 db_VISTA™: The High Performance DBMS
Some major features include:
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- C linkable.
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- **C Compilers:** Lattice, Microsoft, IBM, Aztec, Computer Innovations, Turbo C, XENIX, and UNIX.
- **LAN systems:** LifeNet, NetWare, PC Network, 3Com, SCO XENIX-NET, other NETBIOS compatible MS-DOS networks.

All components feature royalty-free run-time distribution, source code availability and our commitment to customer service. That's why corporations like ARCO, AT&T, Hewlett-Packard, IBM, Northwestern Mutual Life, UNISYS and others use our products.

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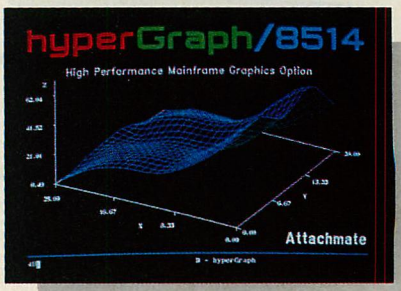
PT 78

Torus Systems' Tapestry II network software package



HyperGraph/8514 screen from Attachmate

printers, that are attached to a server. Price per server for an unlimited number of workstations is less than $3,000. Both Select CS and Select LM will be available the first quarter of 1989. *Digital Communications Associates Inc., 1000 Alderman Drive, Alpharetta, GA 30201-4199; 800/241-4762; 404/442-4000*

CIRCLE 313 ON READER SERVICE CARD

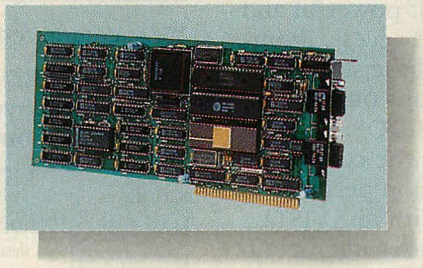
An icon-based network software package that supports OS/2 on both workstations and servers is available from **Torus Systems Inc.** The **Tapestry II Domain Manager Pack** introduces *domain management*, in which domains are logical groupings of PCs rather that physical groupings; domains can be managed from any station on the network, given proper privilege and access. Tapestry II allows any SMB file server, SMB printer, NETBIOS gateway, or NETBIOS interconnect bridge to be fully integrated into the network.

Users can send mail to users on the remote domain, and given proper privilege, can use or even manage the remote domain's resources. Remote users can access a network across telephone lines. The filing system provides comprehensive facilities for managing the contents of local and network drives and allows simple but secure access to shared data on file servers. The Tapestry II electronic mail system allows communication of data among users of the entire network, whether at single or multiple sites.

Tapestry II also features telephone directory management and a multiuser time-management system that offers personal diaries, action lists, and a meeting scheduler. A Tapestry II network consists of a Domain Manager Pack and any combination of extension packs. Tapestry II Domain Manager Pack, $695; prices for 1-, 5-, 20-, and 50-station extension packs, $395, $1,750, $5,995, and $12,500, respectively. Contact the company directly for the price of PS/2 server support. *Torus Systems Inc., 240B Twin Dolphin Drive, Redwood City, CA 94065; 800/872-5335; 415/594-9336;*

CIRCLE 310 ON READER SERVICE CARD

The **Hercules Network Card Plus** is now shipping from **Hercules Computer Technology Inc.** The PC add-in board combines the graphics and text functionality of the Hercules Graphics Card Plus with an AppleTalk network port, allowing networking of PCs to other PCs, Apple Macintoshes, and Sun



Hercules Network Card Plus add-in board

UNIX-based systems using the TOPS network software. The Network Card Plus includes all features of the Hercules Graphics Card Plus, including 720-by-348 pixel resolution and RamFont, Hercules' technology that combines graphics and text modes. The Network Card Plus also allows users to share resources, such as laser printers and hard-disk storage. The integration of video and networking frees an additional card slot and saves PC users the cost of a separate network board. $369. *Hercules Computer Technology Inc., 921 Parker Street, Berkeley, CA 94710; 800/532-0600; 415/540-6000*

CIRCLE 309 ON READER SERVICE CARD

Microcomputer-mainframe software that allows a PS/2 to display mainframe graphics at higher resolutions and speed while consuming less memory than before has been released by **Attachmate Corporation**. The **HyperGraph/8514**, a 3270 software add-on to Attachmate's EXTRA! connectivity software, is designed to take advantage of the IBM 8514 monitor and 8514/A graphics adapter for the PS/2. The software translates mainframe graphics images into special commands used by the on-board processor of the IBM 8514/A adapter, resulting in a 1,024-by-768 pixel resolution. HyperGraph software can significantly speed the drawing of complex images and graphs, and by off-loading some of the image processing to the graphics adapter, it can reduce memory consumption of the software running in the PS/2. $895. *Attachmate Corporation, 3241 118th Avenue SE, Bellevue, WA 98005; 800/426-6285; 206/644-4010*

CIRCLE 307 ON READER SERVICE CARD

Quantum Software Systems Ltd. has introduced **QTERM**, a communications package for QNX—Quantum's multiuser, multitasking, networking realtime operating system. QTERM comprises three software programs: **Qterm**, **QCL**, and **QCP**. Qterm connects the keyboard and screen to any serial or X.25 port; it can manage in excess of 10,000 serial and X.25 devices, providing terminal emulation even for users at dumb terminals, and it allows communication with a remote computer.

QCL, an interpreter for the QNX communications language, is a fully structured, high-level language with communications functions, pattern matching, and file I/O. QCL allows programmers to write scripts that automatically log in to remote systems and perform a set of operations on those systems.

QCP, the QNX communications protocol, implements a highly secure, error-free communications protocol for transferring files over a serial link between QNX systems. QCP provides the error-checked file-transfer protocol

PolyAWK™ – The Toolbox Language™.

For C, Pascal, Assembly & BASIC Programmers.

We call PolyAWK our "toolbox" language because it is a general-purpose language that can replace a host of specialized tools or programs. You will still use your standard language (C, Pascal, Assembler or other modular language) to develop applications, but you will write your own specialized development tools and programs with this versatile, simple and powerful language. Like thousands of others, you will soon find PolyAWK to be an indispensable part of your toolbox.

A True Implementation Under MS-DOS

Bell Labs brought the world UNIX and C, and now professional programmers are discovering AWK. AWK was originally developed for UNIX by Alfred Aho, Richard Weinberger & Brian Kernighan of Bell Labs. Now PolyAWK gives MS-DOS programmers a true implementation of this valuable "new" programming tool. PolyAWK fully conforms to the AWK standard as defined by the original authors in their book, *The AWK Programming Language*.

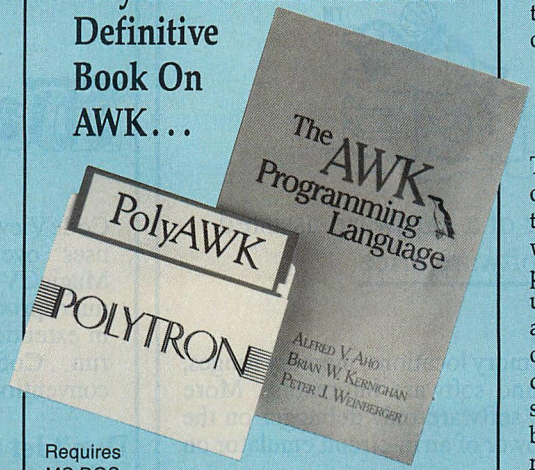
A Pattern Matching Language

PolyAWK is a powerful pattern matching language for writing short programs to handle common text manipulation and data conversion tasks, multiple input files, dynamic regular expressions, and user-defined functions. A PolyAWK program consists of a sequence of patterns and actions that tell what to look for in the input data and what to do when it's found. PolyAWK searches a set of files for lines matched by any of the patterns. When a matching line is found, the corresponding action is performed. A pattern can select lines by combinations of regular expressions and comparison operations on strings, numbers, fields, variables, and array elements. Actions may perform arbitrary processing on selected lines. The action langauge looks like C, but there are no declarations, and strings and numbers are built-in data types.

Saves You Time & Effort

The most compelling reason to use PolyAWK is that you can literally accomplish in a few lines of code what may take pages in C, Pascal or Assembler. Programmers spend a lot of time writing code to perform simple, mechanical data manipulation '— changing the format of data, checking its validity, finding items with some property, adding up numbers and printing reports. It is time consuming to have to write a special-purpose program in a standard language like C or Pascal each time such a task comes up. With PolyAWK, you can handle such tasks with very short programs, often only one or two lines long.

PolyAWK Comes With The Definitive Book On AWK...



Requires MS-DOS 2.0 or above & 256K RAM. **$99**

When you order PolyAWK you receive a copy of *The AWK Programming Language* written by the authors of the original UNIX-based AWK. The book begins with a tutorial that shows how easy AWK is to use, followed by a comprehensive manual. Because PolyAWK is a complete implementation of AWK as defined by the book's authors, you will use this book as the manual for PolyAWK.

You can purchase PolyAWK and the book, *The AWK Programming Language*, for $99. If you already have the book, you can order PolyAWK software only for $85, which is $14 off the regular $99 purchase price. (The book serves as the User's Manual, so you you should already have a copy of the book if you are ordering the software only.)

PolyShell Bonus!

PolyShell gives you 57 of the most useful UNIX commands and utilities under MS-DOS in less than 20K. You can still use MS-DOS commands at any time and exit or restart PolyShell without rebooting. MS-DOS programmers — discover what you have been missing! UNIX programmers — switch to MS-DOS painlessly! PolyShell and PolyAWK are each $99 when ordered separately. Save $50 by ordering the PolyShell + PolyAWK combination package for $149. *Not copy-protected.*

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Prototype With PolyAWK, Translate To Another Language

The brevity of expression and convenience of operations make PolyAWK valuable for prototyping even large-sized programs. You start with a few lines, then refine the program, experimenting with designs by trying alternatives until you get the desired result. Since programs are short, it's easy to get started and easy to start over when experience suggests a different direction. PolyAWK has even been used for software engineering courses because it's possible to experiment with designs much more readily than with larger languages. It's straightforward to translate a PolyAWK program into another language once the design is right.

Very Concise Code

Where program development time is more important than run time, AWK is hard to beat. These AWK characteristics let you write short and concise programs:

- The implicit input loop and the pattern-action paradigm simplify and often entirely eliminate control flow.
- Field splitting parses the most common forms of input, while numbers and strings and the coercions between them handle the most common data types.
- Associate arrays use ordinary strings as the index in the array and offer an easy way to implement a single-key database.
- Regular expressions are a uniform notation for describing patterns of test.
- Default initialization and the absence of declarations shorten programs.

Large Model Implementation

PolyAWK is a large model implementation and can use all of available memory to run big programs or read files greater than 64K.

Math Support

PolyAWK also includes extensive support for math functions such as strings, integers, floating point numbers and transcendental functions (sin, log, etc.) for scientific applications. Conversion between these types is automatic and always optimized for speed without compromising accuracy.

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CIRCLE NO. 144 ON READER SERVICE CARD

SERIOUS DEBUGGING AT A REASONABLE PRICE

All the speed and power of a hardware-assisted debugger at a software price

Hardware-level break points
REAL-TIME break points on memory locations, memory ranges, execution, I/O ports, hardware and software interrupts. More powerful break points than ANY software-only debugger on the market. Soft-ICE gives you the power of an in-circuit emulator on your desk.

Break out of hung programs
With a keystroke - no external switch necessary. Even with interrupts disabled.

Breaks the 640K barrier
Soft-ICE uses ZERO bytes of memory in the first 1MB of address space. This is especially useful for those subtle bugs that change when the starting address of your code changes. With Soft-ICE your code executes at the same address whether the debugger is loaded or not.

Works with your favorite debugger
Soft-ICE can be used as a stand-alone debugger or it can add its powerful break points to the software debugger you already use. You can continue to use your favorite debugger until you require Soft-ICE. Simply pop up the Soft-ICE window to set powerful real-time break points. When a break point is reached, your debugger will be activated.

Solve tough systems problems too
Soft-ICE is ideal for debugging TSRs, interrupt handlers, self booting programs, DOS loadable device drivers, non-DOS operating systems, and debugging within DOS & BIOS. Soft-ICE is also great for firmware development because Soft-ICE's break points work in ROM.

How Soft-ICE Works
Soft-ICE uses the power of the 80386 to surround your program in a virtual machine. This gives you complete control of the DOS environment, while Soft-ICE runs safely in protected mode. Soft-ICE uses 80386 protected mode features, such as paging, I/O privilege level, and break point registers, to provide real-time hardware-level break points.

"Soft-ICE is a product any MS-DOS developer serious enough to own a 386 machine should have."
Dr. Dobb's Journal -- May 1988

NEW! NEW! NEW! NEW!

RUN CODEVIEW IN ONLY 8K

CodeView is a great integrated debugger, but it uses over 200K of conventional memory. MagicCV uses advanced features of the 80386 microprocessor to load CodeView and symbols in extended memory. This allows MagicCV to run CodeView using less than 8K of conventional memory on your 80386 PC.

Don't let 640K be your limit!
If you are closing in on the 640K limit and would like the power of CodeView, MagicCV is for you.

Don't let the debugger hide the bug!
Even if you're not closing in on the 640K limit, running CodeView with MagicCV makes your debugging environment much closer to the end user's program environment. You can use CodeView to locate subtle bugs that only occur when there is plenty of free memory, or those difficult bugs that only occur when your program is running with a couple of TSRs loaded.

How MagicCV works
MagicCV uses the 80386 to create a separate virtual machine for CodeView. MagicCV uses between 4K & 8K of conventional memory as a bridge between the DOS environment and CodeView.

MagicCV is easy to use
If you are a CodeView user, you already know how to use MagicCV too. Just type MCV instead of CV; everything else is automatic.

Save $86

MagicCV	$199
Soft-ICE	$386

Buy Both and **Save $86**

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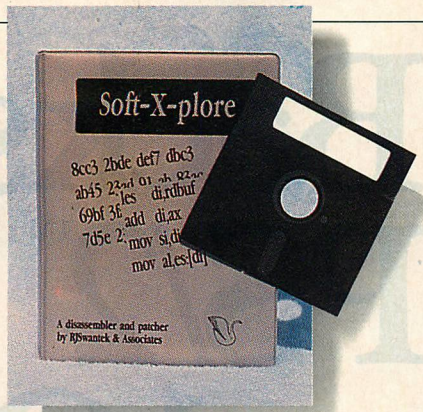
Both require 80386 AT compatible or IBM PS/2 Model 80.
MagicCV requires at least 384K of extended memory.
CodeView is a trademark of Microsoft Corporation.

MagicCV with Soft-ICE
Using Soft-ICE with CodeView gives you the features necessary for professional level systems debugging. MagicCV and Soft-ICE can work in concert with CodeView to provide the most powerful debugging platform you will find anywhere. As an extra bonus, by ordering both MagicCV and Soft-ICE together you **save $86.**



Disassembler from RJSwantek

Digitalk's Smalltalk/V286 programming language

needed by Qterm or QCL to transmit or receive files. QTERM, $150; 4- and 16-node network versions, $300 and $600, respectively.
Quantum Software Systems Ltd., 175 Terrence Matthews Crescent, Kanata, Ontario, Canada K2M 1W8; 613/591-0931
CIRCLE 312 ON READER SERVICE CARD

SOFTWARE DEVELOPMENT

An automated disassembler and patcher from **RJSwantek & Associates**, **Soft-X-plore**, uses four algorithms to separate code from data at a rate of 10,000 lines per minute on a hard disk. Other features include processing for the 80386/87 instruction set, creation of MASM-ready output, automatic generation of comments for DOS and BIOS services, I/O port commands, error messages that explain how to fix the problem, and separate filing of patches for documentation purposes. $99.95.
RJSwantek & Associates, P.O. Box 1032, Hartford, CT 06111; 800/446-4656; 203/560-0236
CIRCLE 323 ON READER SERVICE CARD

The latest version of **SoftPC**, a software product that allows Apple Macintosh II users to access DOS applications, has been unveiled by **Insignia Solutions Inc.** SoftPC's file-sharing architecture makes it possible for the user to integrate DOS and MAC/OS file systems; any file can be accessed transparently through either operating system. SoftPC with DOS 3.3, $595.
Insignia Solutions Inc., 1255 Post Street, Suite 625, San Francisco, CA 94109; 415/771-7001
CIRCLE 322 ON READER SERVICE CARD

An 80286- and 80386-based implementation of the Smalltalk object-oriented programming language is offered by **Digitalk Inc. Smalltalk/V 286** runs in protected mode and can address as much as 16MB directly. Smalltalk/V 286 is designed to operate with both DOS and OS/2 and is compatible with Smalltalk/V. It includes multitasking and supports separately loadable applications, providing developers an environment in which they can distribute their applications. Developers can use it to build systems with more than 32,000 objects, and objects can be larger than 64KB due to the expanded memory capacity. $199.95; upgrade from previous versions, $75.00.
Digitalk Inc. 9841 Airport Blvd., Los Angeles, CA 90045; 800/922-8255; 213/645-1082
CIRCLE 321 ON READER SERVICE CARD

An enriched version of **Media Cybernetics**' library of graphics subroutines, **HALO '88**, features the ability to manipulate and control scanners and scanned images. HALO '88 has added hardware support for the IBM PS/2, 43 graphics adapter boards, 20 printers, and 11 scanners, bringing the total number of supported devices to 144. A disk-based virtual raster interface for EMS, as well as system memory, has been added. Extended character-set support enables software developers to address IBM's full 255 characters in graphics and to design foreign-language fonts. $325; update, $150.
Media Cybernetics, 8484 Georgia Avenue, Silver Spring, MD 20910; 800/992-4256; 301/495-3305
CIRCLE 325 ON READER SERVICE CARD

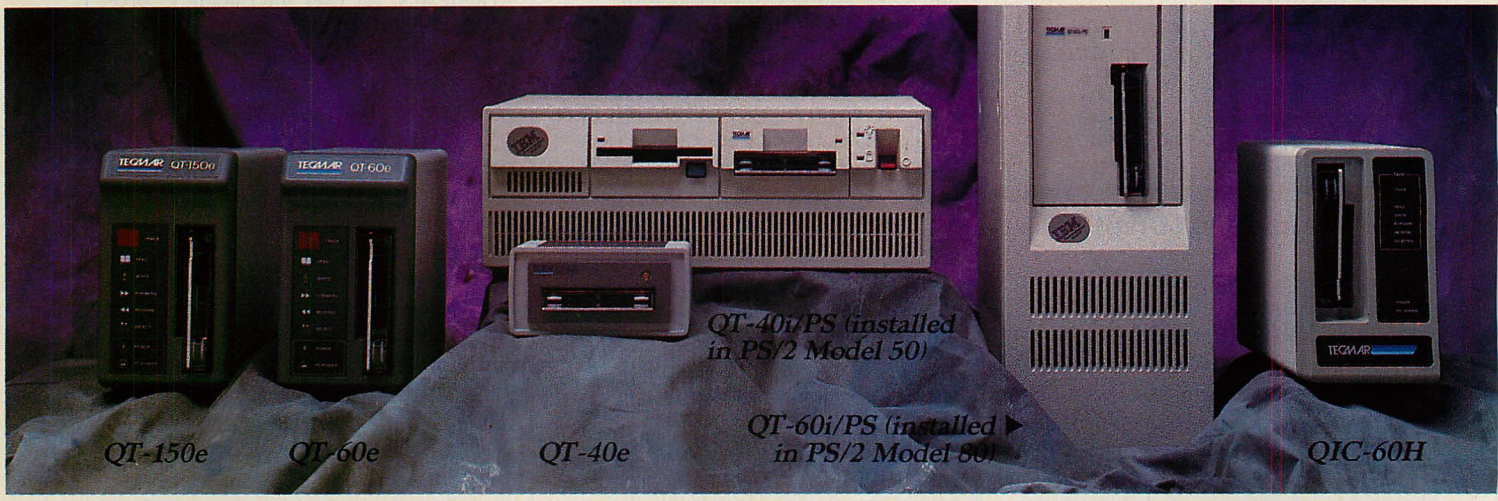
A full implementation of **OPS83**, an AI expert system programming language previously available only on larger systems (such as the DEC VAX, HP 9000/33, AT&T 3B, Masscomp, Stratus, Sun 3, and Apollo Domain), will now run on the PC, according to **Production Systems Technologies Inc.** As a compiled language, OPS83 offers small application program code size. The OPS83 runtime system, linked to an application program, requires only 50KB of memory on the PC. OPS83 is written in C for easy interfacing to programs written in other languages. PC version, less than $2,000.
Production Systems Technologies Inc., 5001 Baum Blvd., Pittsburgh, PA 15213; 412/683-4000
CIRCLE 324 ON READER SERVICE CARD

Polytron Corporation has introduced the **Polytron Version Control System 2.0** (PVCS), a configuration and management system that stores the revision history of source files and maintains chronological records of changes. PVCS 2.0 can reconstruct any prior revision of a module, define a version as specified revisions of various modules, and support multiple lines of development from a common ancestor. Disk space is conserved because only the differences between successive revisions of a module are stored. The latest revision of a program is instantly available, and any prior revision can be reconstructed quickly.

The enhanced package includes a screen-oriented menu interface and the ability to use aliases (a name defined to be equivalent to a list of one or more file names). An alias can be used in configuration files, command files, or on the PVCS command line to change a particular variable automatically. After each logical line of configuration file or command file is read, the aliases in it are replaced by their equivalent text strings. Single-user version, $395; 5-station LAN, $995; upgrade from previous version, $50.
Polytron Corporation, 1700 N.W. 167th Place, Suite 2110, Beaverton, OR 97006; 800/547-4000; 503/645-1150
CIRCLE 319 ON READER SERVICE CARD

OASYS Inc. and **Sierra Systems** have signed an agreement under which OASYS will make available its **Sierra C**

Tecmar Backs Up the PS/2™ Inside and Out.



An advanced personal computer like the PS/2 demands advanced data protection. That means Tecmar tape backup.

Long the leader in backup for XT®s and AT®s, Tecmar also offers a wide selection of both internal and external tape systems for the PS/2. And, with over 30,000 PS/2-compatible units in the field, we're already the leader in PS/2 backup.

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Select from our economical 40MB floppy-interface model or high-performance models in 60 to 150 MB capacities. And now PS/2 interface adapters are available for the QIC-60H.*

And More.

All Tecmar QT tape systems use the popular and user-friendly QTOS™ menu-driven software and are covered by our exclusive QuickTurn™ Quality Service and two-year warranty. So choose your tape system solution from the leader in PS/2 backup—Tecmar, quality inside and out. Call us now at **(800) 624-8560** or (216) 349-1009. Tecmar, Inc., 6225 Cochran Road, Solon, Ohio 44139-3377

**QIC-60 tape drives use QIC software, are covered by a one-year warranty and are not covered by QuickTurn Quality Service.*

TECMAR

The Power Behind Your PS/2

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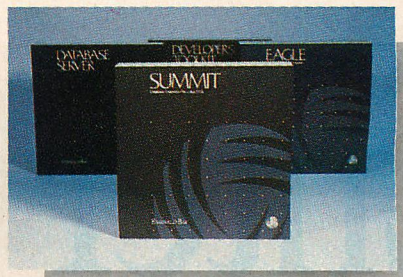
CIRCLE NO. 225 ON READER SERVICE CARD

Relational data management system from Caltex



Migent's Emerald Bay database products

68020 Cross Development Package for the IBM PC/AT. Designed for embedded systems development, it includes an optimizing 68020 C Compiler with C preprocessor and ANSI C extensions, an assembler, linker, absolute address mapper, configurable command driver, libraries in source format, and serial and parallel downloaders.

OASYS also announced that native and cross-development toolkits for the Intel 80386 microprocessor are now available on 68000- and 80386-based workstations. **OASYS 80386** compilers provide full support for the Intel 80387 and the Weitek 1167 and have interlanguage calling capability. Contact the vendor directly for prices.

OASYS Inc., 230 Second Avenue, Waltham, MA 02154; 617/890-7889

CIRCLE 320 ON READER SERVICE CARD

Sierra Systems, 6728 Evergreen Avenue, Oakland, CA 94611; 415/339-8200

CIRCLE 333 ON READER SERVICE CARD

A translator that automatically converts PL/M code into logically equivalent C code is available from **Micro-Processor Services Inc. PLC86** features a syntax analyzer that scans the PL/M 86 input file for syntactic errors, generates a listing file of the PL/M 86 program, and flags the errors with English messages in the listing file. $475.

Micro-Processor Services Inc., 92 Stone Hurst Lane, Dix Hills, NY 11746; 516/499-4461

CIRCLE 335 ON READER SERVICE CARD

A complete library of compiled functions for Borland's Turbo Pascal 4.0 has been announced by **Blaise Computing Inc. POWER TOOLS PLUS/4.0** includes interrupt support procedures to allow programmers to install a Turbo Pascal procedure as an interrupt service routine or as intervention code to be triggered at certain times of the day or when hot keys are pressed. Features include precise cursor control, setting of screen attributes, support for multiple display pages, vertical and horizontal scrolling, screen input and output, and fast video access without video interference. Both EGA and VGA are supported in text mode, including 43- and 50-line modes. Multiple windows can be constructed with borders, attributes, and cursor control. $129.

Blaise Computing Inc., 2560 Ninth Street, Suite 316, Berkeley, CA 94710; 415/540-5441

CIRCLE 334 ON READER SERVICE CARD

Blueprint, a data-access architecture that will enable PC users to link directly with a range of data sources from within their Lotus applications, will be available in the fourth quarter of 1988 from **Lotus Development Corporation**. The Blueprint toolkit will allow developers to build Blueprint drivers for data sources ranging from live data feeds and CD-ROM disks to PC, minicomputer, or mainframe data management systems. Blueprint Toolkit, including Blueprint specification and related code libraries, $250.

Lotus Development Corporation, 55 Cambridge Parkway, Cambridge, MA 02142; 617/577-8500

CIRCLE 337 ON READER SERVICE CARD

DATA MANAGERS

Emerald Bay is a database technology comprising four products that will allow microcomputer users in a network to share the same information, even when working in different applications or on noncompatible operating systems, according to **Migent Inc.**

The language-independent **Emerald Bay Database Server** enables all Emerald Bay applications to provide multiuser service. The **Eagle** is Emerald Bay's database language, and the **Developer's Toolkit for C Language** is a set of utilities that provides access to the database engine. Both the Eagle and the Toolkit include a personal engine, report writer, form generator, database administrator, and import/export capabilities. **Summit**, a Lotus 1-2-3 add-in, links the spreadsheet to Emerald Bay databases and gives the user multiple views of the data. Database Server, $695; Eagle, $495; Toolkit, $495; Summit, $195.

Migent Inc., 865 Tahoe Blvd., Call Box 6, Incline Village, NV 94850-6062; 800/777-2027; 702/832-3700

CIRCLE 326 ON READER SERVICE CARD

A fourth-generation language relational data management system, **D the data language**, is offered by **Caltex Software Inc.** Features include a three-step data-manipulation process (isolate, arrange, and report), extensive file import/export capabilities, unlimited number of data files per database, and an on-line example database. $395.

Caltex Software Inc., 3131 Turtle Creek Blvd., Suite 1101, Dallas TX 75219; 214/522-9840

CIRCLE 327 ON READER SERVICE CARD

MUST Software International has announced the release of **PC NOMAD 2.0**, a fourth-generation language data manager. Major enhancements include virtual and extended memory management capabilities, cooperative processing facilities for building applications that distribute functions and procedures between microcomputer and mainframe, enhanced windowing facilities, reverential integrity to ensure validity, and multiple tools. $795.

MUST Software International, 101 Merritt 7, Norwalk, CT 06856; 203/845-5000

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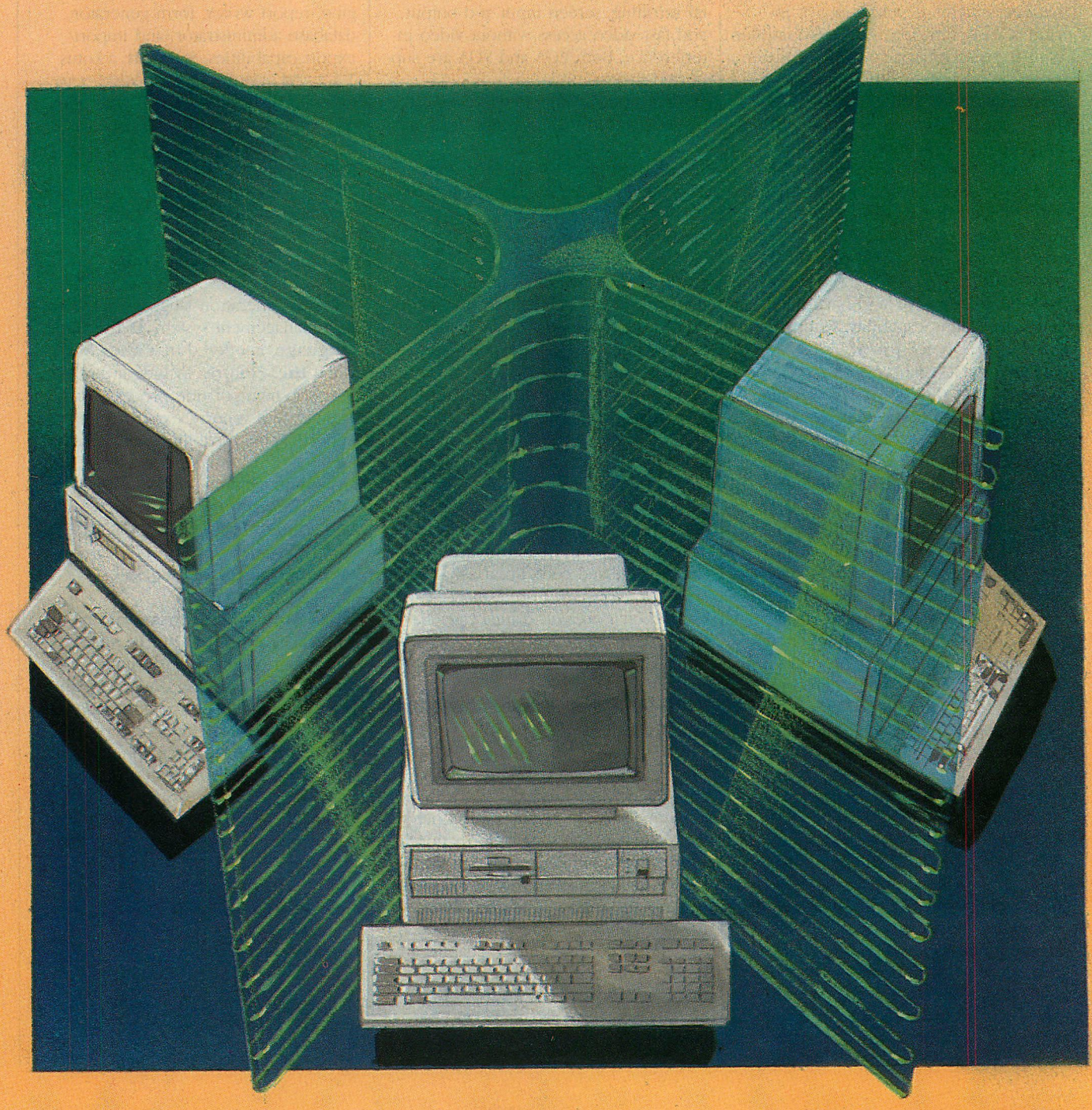
The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

Enter the Macs



In the world of high-performance desktop computing, brains and good looks are not always enough to get what you want—sometimes you have to have connections.

ILLUSTRATION • NED SHATZER

WILLIAM CASEY

Long regarded as an industry counterculture by the PC-based majority, Apple Computer stepped squarely into the business arena with its release of two powerful, second-generation Macintosh models in early 1987. The Macintosh II and Macintosh SE are faster, more powerful, and offer better functionality than their predecessors. Not only that, they have system units that can be opened to the light of day—a move with intriguing ramifications. Apple continues to base its machines on the Motorola 68000 family, which complicates their integration into Intel-based environments; nevertheless, their higher profile will help establish their hold in many offices and thus force the issue.

Many organizations already wrestle with some variation on a theme of shared heterogeneous information processing. These issues take on various faces in a world of PCs, PS/2s, and compatibles—integrating with mainframes and minicomputers, connecting to each other via networks, achieving operating system and application software stability. The growing presence of the Mac compels the systems integrator to figure it into the equation as well.

The Macintosh II, Macintosh SE, and their older sibling, the Macintosh Plus, make up this complete family of general-purpose business machines. (The three machines are shown in an accompanying photo; table 1 lists their specifications along with those of an IBM PS/2 Model 80 for comparison.) Both the Mac Plus and the SE feature a single 3.5-inch diskette drive; the SE can accommodate a second diskette drive or a 20MB hard disk. The Macintosh II, which runs at 15.7 MHz (twice the speed of the Plus and the SE), is comparable to the 80386-based Model 80. The Mac II supports one or two 3.5-inch diskette drives and a 20MB, 40MB, or 80MB internal hard disk; it is also the first Mac to offer a *separate* monochrome or color monitor.

As recently as three years ago, connecting PCs and Macs was an interesting notion at best, but 1987 changed that. According to the market-research firm Dataquest, Apple shipped more than 1.2 million units (of all kinds) last year in the United States alone. The comparable number of IBM and compatible units shipped was 5.9 million. Of the 1.2 million Apple units shipped, Macs accounted for 630,000—quite a jump from the 371,000 shipped in 1986. The PC-to-Mac ratio is not so disparate as it once was.

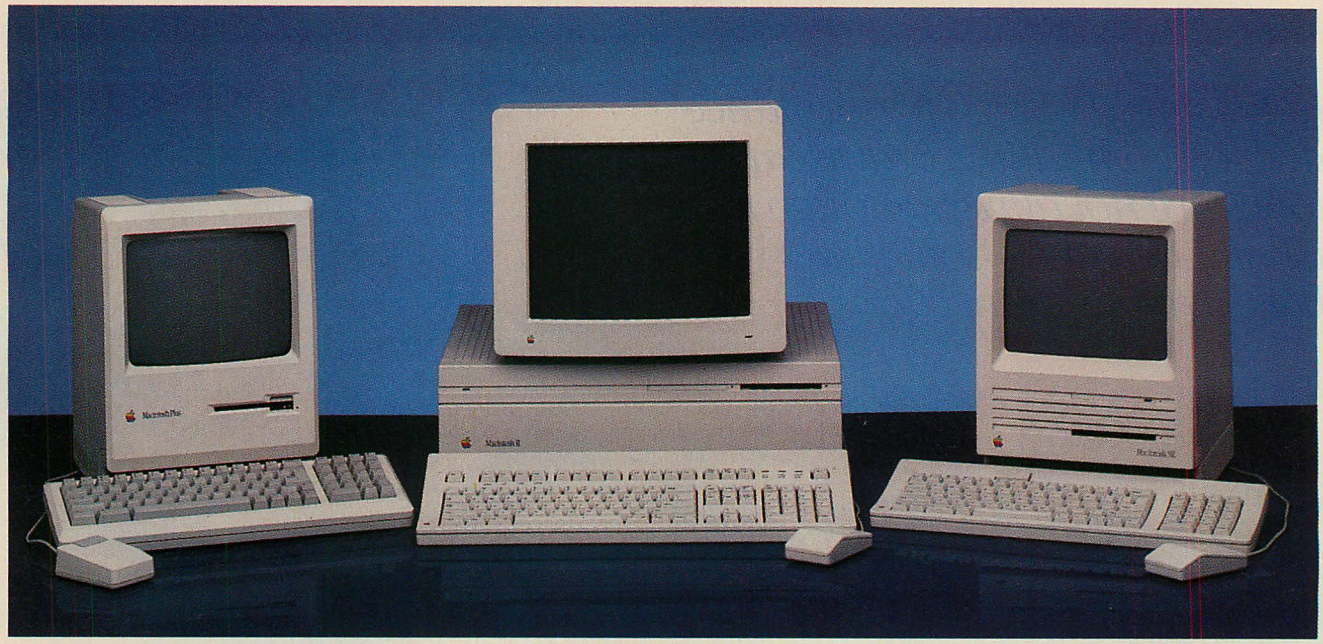
A roundup of projections for 1988 reveals that the Macintosh is the machine of the hour. The Palo Alto Research Group, for example, projects an installed base of more than 2.2 million Macs by the end of 1988, with 65 percent predicted to go into business situations. Another firm, Genesis Research Associates of Los Altos, predicts the sale of 690,000 Macs in 1988 (23 percent of those Mac IIs), with 53 percent going to business. Whatever the actual numbers turn out to be, the trend is clear: corporate America is embracing the Mac with growing enthusiasm, and the connection of PCs and Macs is a question that must be addressed by the third-party contingency.

This month's cover suite, entitled "Mac Connections," includes two other articles that address available PC-Mac connectivity options. The first article, "PC-Mac Link" (Howard Marks, p. 52), takes a close look at 3Com's 3+ for Macintosh, which reaches out to Macs from 3Com's well-established 3+ Share network operating system. 3Com is a leader in networking the Macintosh, having shipped its first Mac network product, EtherMac, September 1985. The second article, "Macintosh Meets the Mainframe" (Paul Firgens, p. 66), considers the Mac connection to IBM mainframes via the MacIRMA board and software from Digital Communications Associates.

FATAL ATTRACTION

Macs always manage to attract attention—even of loyal PC users. If the icon-based interface doesn't catch your eye, then maybe the unusual sound capabilities will speak to you. Or maybe it will be the crowd of curious onlookers that draws you closer. What is beginning to *keep* more users in front of the machine is the increased power, performance, and software options.

Tultex Corporation, a major apparel manufacturer headquartered in Martinsville, Virginia, is one company dealing with a Mac invasion. Tultex has roughly 300 IBM PCs and compatibles on which it runs a variety of stand-alone and connected applications. Theirs is a sophisticated, large-scale, data-processing operation centered around IBM mainframes, but which is moving toward Digital Equipment Corporation (DEC) hardware as well. The



The current Apple Macintosh family consists of three models, all featuring a Motorola 68000 family 32-bit processor. The Macintosh Plus (left) and Macintosh SE (right) consist of a system unit with an integrated monochrome display. The Macintosh II (center), with its separate display (color or monochrome), is similar in appearance to IBM's desktop PS/2 models.

company is happy with its PC environment and expects to expand it aggressively over the next several years.

A walk down "mahogany row," though, tells the Mac tale. This section of Tultex's headquarters is home to company executives, and on nearly every desk sits a Macintosh, with only a few PCs. "The executives wanted computing power," says director of information systems Hugh McDonald, "but they insisted on something easy to use. The Macintosh was a much friendlier environment for them, much easier to learn, and more 'fun,' too."

The Tultex Macs connect to the corporate mainframe using AppleTalk and the TOPS (Sun Microsystems) local area network via Tri-Data's Netway 1000A 3270 gateway. Interestingly, the kinds of data Tultex executives request are in many cases the same kinds of data downloaded to the IBM compatibles. Tultex's Macs are being used for the same financial and planning applications as their blue relatives, not simply desktop publishing and other graphics uses that are thought of as *the* Macintosh applications.

VISIONARY OR PROPRIETARY?

Apple has always presented itself as having a "vision" of how personal computing should be—a vision of simplicity, of a more engaging interaction via the mouse, and of graphics homogeneity. Part of this vision includes separating developers and their software from the underlying hardware.

The Mac was conceived and implemented fundamentally as a hardware- and device-independent machine, in which programs accessed hardware indirectly and exclusively through an application program interface (API) consisting of Apple-supplied, ROM-based QuickDraw (screen display) and toolbox routines. The size of a user's video display, its resolution, and the exact nature of output devices were handled at the system level, not at the application level. IBM PC users are just encountering this layered separation with OS/2, Presentation Manager, and Microsoft Windows.

Perhaps the biggest strike against the Macintosh from a pure computer-engineering standpoint has been its closed case. This Apple characteristic has always been a sensitive issue. Apple did itself no favors with this decision. In-house equipment maintenance is often a key issue with large organizations. Potential users also inferred that a closed machine would generally rule out third-party hardware enhancements, which was something they had grown comfortable with using IBM PCs. Apple appeared to be situating itself as sole supplier for the Mac.

The proprietary operating system Apple includes with the system comes in two pieces, the System and the Finder, each of which use the Mac's ROM-based toolkit functions. The System contains utility functions, desk accessories, font information, and message handlers. The Finder is more of a visual desktop manager, allowing the user to arrange screen objects according to personal preference. The user exercises direct visual control over what the desktop environment looks like. It is intuitive and works well, and it is fun.

CORPORATE AMERICA SAYS YES

The Mac began appearing in isolated corporate graphics and art departments within its first year, but it took two additional events to launch the system into the business environment.

Apple introduced its Macintosh Office software in January 1985 and with it the $7,000 PostScript-based LaserWriter. No other single product has been as significant in the Mac's history as the LaserWriter. Intended as a shared resource, the LaserWriter can be connected to multiple Macs inexpensively via the new AppleTalk Personal Network. All that was missing were major league applications to take advantage of the new capabilities.

By July 1985, Aldus Corporation had introduced PageMaker 1.0 for the Mac, a package that revolutionized the integration of graphics and text and ushered in the desktop publishing era. Within two years, Aldus had sold more than 100,000 copies of PageMaker, with many turning up in places where Macs themselves had not been seen before.

These numbers are not extraordinary compared with the PC/Lotus 1-2-3 phenomenon only because the industry had matured and was poised to create

similar page makeup products. (Apple maintains its edge in desktop publishing but is increasingly threatened by improved IBM-side capabilities.) More importantly, the people doing the work on Macs were not computer hobbyists—they were writers and artists who did not know an MIS from an EDP.

With this foothold, the Mac had a base of operations for cracking the corporate world. The real issues of ease of use and ease of training could be better appreciated with Macintoshes on-site and productive.

In addition, Apple's attitude toward the IBM world had changed drastically and, most observers feel, for the better. Apple began stressing connectivity issues in 1985, and it has supplemented the Mac's networking opportunities with boards and software that enable it to be compatible with IBM System Network Architecture (SNA), Digital Equipment Corporation's DECNet, and ISO's Open System Interconnection (OSI) environments. Emphasis on products that grant "recognition" to mixed hardware office environments, making productivity easier for any and all users, has become the theme.

GETTING ON TO MACBUSINESS

Released in January 1984, the original Macintosh was a primitive machine, with only 128KB of RAM and 128KB of ROM, but it worked. Its most noteworthy contributions to personal computing may have been the introduction of the smaller footprint and the now-ubiquitous mouse.

Responding to pressures from both its users and third-party developers during the next two years, Apple produced the 512KB Fat Mac, also based on the 68000 hardware. The Fat Mac began the process of bringing the machine up to commercial performance levels, but even 512KB was not enough memory for the more-ambitious software being churned out.

Today, the three Macintosh standard bearers are the Plus, II, and SE. The Macintosh Plus came out in early 1986 and still is sold as the low-end model of the Mac line. The Plus represents the fullest (although not necessarily final) evolution of the original Mac. The two machines look the same, but internally the Plus tells the story of a product line "grown up."

The Mac Plus has a standard 1MB of memory, which can be upgraded to 4MB. Its mass storage provisions consist of a standard 800KB 3.5-inch diskette drive and a port for an external drive as well. Another feature is the 312KB-per-second (KB/sec) SCSI (small computer systems interface) port, which can be used to serially attach as many as seven external hard disks or other devices (Apple or third-party). Internal hard disks are available from third-party vendors but not from Apple. The Plus has an improved keyboard with 78 keys, including arrow keys.

Even with its advances, though, the Mac Plus is best suited for home use. Most business users are more interested in Apple's two major-league players, the Macintosh SE and the Macintosh II, both of which were introduced in March 1987.

The SE is the more characteristically Mac machine, but its redesigned hardware and software components make it run better and faster. Although the SE is based on the same 68000 CPU running at 7.83 MHz, it generally is acknowledged to operate about 1.5 times faster than the Plus—the result of various minor adjustments. Two major hardware improvements are the use of application-specific integrated circuits (ASIC) on the system board and a 600KB/sec SCSI port.

The SE has a standard 1MB of RAM, but users commonly upgrade to 2MB or even 4MB. This model supports three diskette drives—two external and one internal. A 20MB internal hard disk is available in place of the second internal 3.5-inch diskette drive, and external 20MB, 40MB, and 80MB SCSI hard disks are also available.

The system board in the SE has space for an optional coprocessor; presumably at some point Apple will encourage higher-octane processing via a simple field-type upgrade to the SE chassis. On the software side, the SE's ROM was bumped up to 256KB ROM (it is similar but not exactly the same as the Mac II ROM) with many of the critical routines reengineered for greater speed.

The SE is the first "open" Mac in that it includes a single expansion slot, which is an extension of the 68000 bus.

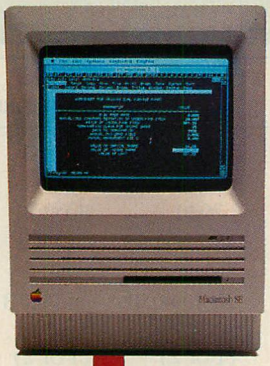
TABLE 1: ***Macintosh and PS/2 Model 80 Features***

	MACINTOSH PLUS	MACINTOSH SE	MACINTOSH II	PS/2 MODEL 80
Price[a]	$1,799	$3,698	$6,996	$7,680
Year released	1986	1987	1987	1987
CPU	68000	68000	68020	80386
Clock speed	7.83 MHz	7.83 MHz	15.7 MHz	16 MHz
Math coprocessor	No	No	68881	80387
Hard disk	No	20MB[b]	20/40/80MB	44/70MB
Internal diskette drive (quantity)	800KB (1)	800KB (1 or 2)	800KB (1 or 2)	1.44MB (1 or 2)
External diskette drive	400 or 800KB	400 or 800KB	No	360KB
System RAM	1 to 4MB	1 to 4MB	1 to 8MB	1 to 16MB
System ROM	128KB	256KB	256KB	128KB
Video output	Monochrome	Monochrome	Gray scale and color	Gray scale and color
Resolution (pixels)	512-by-342	512-by-342	640-by-480	640-by-480
Bus	Proprietary	Proprietary	NuBus	Micro Channel
Bus width	24/32 bits	24/32 bits	32 bits	16/32 bits
Expansion slots	No	1	6	8
Serial ports	2	2	2	1
Pointing-device ports	1	1[c]	1[c]	1
Sound ports[d]	1	1	1	No
Number of keys	78	81 or 105[e]	81 or 105[e]	101
Fan	No	Yes	Yes	Yes
Case	Locked	Open	Open	Open

[a] All systems include 1MB RAM. Hard-disk sizes on the Macintosh SE, Mac II, and PS/2 Model 80 are 20MB, 40MB, and 44MB, respectively. Mac II and Model 80 prices include color monitors.

[b] Takes place of second internal diskette drive.
[c] Can support up to 16 daisy-chained devices.
[d] For connection to external sound equipment.
[e] Two different keyboards are available.

The Mac II currently supports up to 8MB on the system board; memory can be added using NuBus memory expansion boards. It is designed to accommodate up to 128MB on the system board and up to 2GB of memory on expansion boards.



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This slot often is used to support a large video display, especially for desktop publishing, but it also can accommodate third-party boards for color displays or networks. Besides SCSI hard disks, an Apple 20MB hard disk is available with the SE.

The Mac II carries little from its ancestors. It is largely a machine that breaks new ground, yet it retains the essence of what has made the Apple line special. Powered by a 15.7-MHz Motorola 68020, the Mac II also has a standard MC 68882 floating-point math coprocessor. From a hardware perspective, the Mac II is commonly (and appropriately) compared with the Intel 80386-class of processors. The Mac II is fast, with a throughput generally 3 to 4 times that of a Mac Plus.

Also standard with the II is an 800KB 3.5-inch diskette drive, with an option for a second. The 20MB, 40MB, and 80MB internal and external SCSI hard disks are options. Apple opened the hardware box even farther with the Mac II, which has slots for six expansion boards. One is filled by a video display controller board; video display memory is on this board rather than in the main portion of RAM, a feature that has boosted performance.

The Mac II expansion bus architecture is a 32-bit address and data bus built around a variant of the IEEE-standard NuBus, a design licensed from Texas Instruments. Using this architecture, the Mac II can support a wide range of current and future add-in boards, none of which requires the setting of jumpers and switches for proper interrupt vectors, address ranges, and so on. The relative ease of configuring even a large, elaborate Mac II is impressive.

The Macintosh II comes with 1MB of RAM standard on the system board, expandable to 8MB. Additional memory can be installed on expansion boards; RAM expansion boards of 1MB and 2MB currently are available from Apple. The Mac II will accommodate up to 128MB of RAM on the system board and 2GB on expansion boards when suitable higher-density RAM devices become available.

The traditional Mac footprint has been abandoned with this model for a more standard-looking, 19-inch system unit. In another break from Mac tradition, the screen is not built-in. The user can choose a monochrome monitor (256 shades of gray) or one of several high-resolution color monitors (resolutions beginning at 640-by-480 pixels). Frequent announcements are made of high-end, third-party Mac II color boards (supporting 256 colors from a palette of more than 16 million) and companion monitors in the $5,000 to $7,000 range.

These monitors display as much as two full pages of text and offer resolutions of a million pixels or better. In addition, the Mac II user can have multiple monitors—monochrome, gray scale, color—that can be assigned to contiguous placement on a user's desktop and arranged to suit individual needs. Remarkable flexibility and expandability are hallmarks of the Mac II.

Both the SE and the II can support either the 81- or 105-key keyboard from Apple. The 105-key model is similar in appearance to the 101-key IBM enhanced keyboard, featuring 15 function keys across the top and an inverted T-shaped cursor pad.

The Mac II is largely a machine that breaks new ground, yet it retains the essence of what has made the Apple line special.

On the software side, Apple has stayed on the cutting edge of innovation, having released a number of improved versions of the system software. One of the earliest major improvements was HFS, Apple's Hierarchical File System, which extended the folder and contents metaphor and mechanics for efficient use in the hard-disk world.

The hierarchical file system speeds up access to files stored on large volumes by storing files in directories, which also can contain subdirectories. HFS file directories are presented to the user as folders on the visual desktop. HFS provides more efficient access to files on large volumes than the original Mac file manager. That version used a flat file system, with the organization of folders being maintained by the Finder.

HFS was a welcome, but predictable, development. Switcher, first released in 1985, was a more significant step. Like much Mac software, Switcher supported context switching, enabling the user to load, for example, Excel and MacWrite into RAM and move between them easily. (Without the PC's 640KB limitation, a Mac user could divide a megabyte or more of memory into pieces of whatever size was convenient and assign them to as many as four application programs.)

Switcher floated around user groups and on bulletin boards, and ultimately Apple packaged it and ensured its widespread use, despite its tendency to behave erratically when hardware or software environments changed.

The 1987 introduction of MultiFinder, Apple's first multitasking operating system, eclipsed Switcher in both function and reliability. Another Apple innovation released in 1987, Hypercard, is best described as an associative information environment, enabling the user to tap into many levels of software. Both products have been important to the company and its users. Determined to give and maintain a high profile for its products, Apple has supported its recent technological advances with effective promotion.

PEACEFUL COEXISTENCE

So, you have a PC or two, and that Mac nearby looks awfully inviting for manipulating and displaying data living in the PCs. Or, you have a Mac Plus or Mac II, and you have been composing, calculating, drawing, cutting, and pasting. At some point, you may be compelled to reach out for non-Macintosh-based files. What do you do now?

At least two levels of data exchange are available: low-level transfer of appropriate data files, and translation between different data formats at an application level. The lower level is a problem with the Macintosh machines because their physical file representation is different from the IBM world—the Mac cannot read an IBM-format 3.5-inch diskette in its drive and vice versa. Even though the two systems use the same physical media, they format and access it differently.

Mac 3.5-inch diskettes are either single- or double-sided with a formatted capacity of 400KB or 800KB, respectively. They use 512-byte sectors and contain 80 tracks divided into 5 groups of 16 tracks each. Each group of tracks is accessed at a different rotational speed, so that the linear speed of the media passing under the read/write head is the same for each group. PS/2 3.5-inch diskettes are double-sided with a formatted capacity of 720KB or 1.44MB, contain 80 tracks with 9 or 18 512-byte sectors each, and are accessed using a constant rotational speed.

PC and Macintosh users can handle low-level data movement in several ways. One method is to make transfers

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via telecommunications or direct serial cable. Getting data files through a modem on a file-by-file basis is still the most prevalent method. Basic communications software such as MacTerminal (still owned by Apple), Microphone (Software Ventures), or a dozen others can handle external services and corporate mainframes and can do file transfer with corresponding products on the PC side (Crosstalk, Smartcom) as well.

The results are not fancy but the data get through. On the cable side, Dataviz (with MacLink Plus) and other suppliers make a substantial business of selling the basics of connecting PCs to Macs via a serial-port-to-serial-port cable, with software programs on each machine to move and translate data.

Reading and writing alien diskettes is another approach. Central Point Software markets an option board that writes Mac-format 3.5-inch diskettes in a PS/2 Model 30, and Micro Solutions offers a PC expansion board that permits a Mac-format 3.5-inch diskette drive to be used with a PC.

Apple stresses the diskette approach with its Apple File Exchange, for which the key piece of hardware is Apple's PC 5.25 Drive, which connects to a Mac SE or Mac II via an expansion slot and reads and writes DOS files. Dayna markets several drives, both 3.5-inch and 5.25-inch, that plug directly into the Mac's SCSI port. Peripheral Land's Infinity diskette drives also attach to the SCSI port and have a 10MB capacity; they can read both 360KB and 1.2MB IBM 5.25-inch diskettes. The drive is designed primarily as a Mac storage device; any data translation must be performed by application packages.

For direct transfers using the SCSI interface, Quickshare from Compatible Systems consists of a PC expansion board and appropriate software for the PC and Mac to allow the transfer of files between the two. In addition, Quickshare can be configured to allow the Mac to access and even boot from a portion of the PC's hard disk as if the disk were directly attached to the Mac.

Some local area networks (LANs) also support transfer and sharing of data between the two architectures. LANs are especially appropriate for frequent transfer or sharing of data among PCs and Macs. Current products include TOPS and 3Com's 3+ for Macintosh. These networks support electronic mail and message services and allow the sharing of resources, such as modems and printers, in addition to the transfer and sharing of data.

Data also can be transferred to and from a mainframe from both machines. Particularly in large corporations, the data to be manipulated on the Mac are stored on a mainframe computer or a PC attached to the mainframe. Tri-Data's Netway 1000A emulates an IBM 3274 terminal controller, permitting AppleTalk-connected Macs to communicate with System/370 mainframes. DCA's MacIRMA provides similar services using an expansion board and a coaxial cable connection to a 3274 terminal controller or an IBM 9370 workstation controller.

The real challenge in data conversion comes in at the application level or higher. Higher program intelligence is required, in the sense that file structures and encoding techniques become issues. This level involves interchangeability of application program data, which can be a problem even on a single machine: How does a user convert a MultiMate document to Microsoft Word without writing out a plain ASCII file and thus losing formatting and other special features?

Although Apple guards its technology aggressively, chances are good that Macintosh clones will appear on the market before long.

The solution is a list of translators that fit into an overall file interchange architecture. For example, Apple uses what appears to be Dataviz's shell for its File Exchange software, but it includes only a few translator modules (WordStar, MultiMate); the user is encouraged to contact Dataviz for additional modules. Dataviz also provides this software basis for Dayna's Dayna-File peripherals. Apple provides software support for IBM's Document Content Architecture (DCA) format, another widely used standard for moving text files between systems.

Such generalized methods are not always necessary for the PC-Mac user, however. Increasingly, application vendors are addressing the data translation issue, with Microsoft in the lead. Microsoft Word users can write files on the Mac in one of six formats besides normal and can read from a number of other word-processor or file-interchange modes. Excel (on the Mac) can read .WKS files directly, handling formulas and most display formats. The desktop publishing industry also will figure prominently in the sharing of high-level data because these packages must be able to import from a variety of common word processor sources. The results are not always perfect, but these methods are in widespread use and should improve steadily.

A BITE INTO THE FUTURE

Talking to Macs may not be at the top of every systems manager's to-do list right now, but transferring and sharing data among Macs and PCs is fast becoming a serious issue in numerous corporate environments.

Apple's philosophy and market strategies may play an interesting role in the positioning of its Macintosh machines against IBM models. For example, it was no coincidence that Apple introduced the new Macs in March 1987, just one month before IBM's new PS/2 line was unveiled. Apple felt the heat of IBM's impending announcement and moved quickly to release its new machines first.

In addition, chances are good that Macintosh clones will appear on the market before long. Although Apple continues to guard its technology aggressively, it is only a matter of time before the functionality of its rather complicated Mac ROM is duplicated. Some Apple observers contend that the company is foolish not to recognize that the success of the IBM architecture was due in large part to its widespread availability in lower-priced compatibles.

As a rather pragmatic consideration, although IBM machines and compatibles are still the dominant machines in the business arena, every year a new group of young professionals in all disciplines is graduated from an educational system that continues to be dominated by Apple.

No, the Macs haven't just come to visit, they're here to stay.

Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014
408/996-1010
Macintosh II; Macintosh SE; Macintosh Plus

CIRCLE 339 ON READER SERVICE CARD

William Casey lives in Minnesota where he heads SystemCraft Inc., consulting on large and small systems issues. He has 20 years of experience with IBM mainframes and a variety of microcomputers.

PC-Mac Link

A forerunner in an exciting new arena, 3Com's 3+ for Macintosh connects Macs and PCs on the same network, with one caveat: Mac services are not yet up to par with PC network functionality.

HOWARD MARKS

Users of stand-alone Macintoshes may prefer Apple's icon-driven graphics interface and powerful desktop functionality, only to be disappointed when they cannot access LAN file servers, mainframe gateways, and other network resources that are commonly available to PC users. What all users really want is a quality interface and network services on the workstation of their choice.

Mixed networks of PCs and Macs make this possible but require advanced network products and substantial integration efforts on the part of systems personnel. With 3+ for Macintosh (3+Mac), 3Com Corporation brings advanced network services and PC resource sharing to the Macintosh.

3+Mac is an extension of 3Com's 3+Share network operating system (NOS), which runs primarily on 3Com's 3Server line of dedicated file servers and supports Ethernet, Token-Ring, and AppleTalk. 3+Share is a derivative of the Microsoft Network (MS-NET) software; its performance is best on the 3Server, but it will operate on PC servers as well.

With no screen or keyboard (see photo on page 54), the 3Server is a production machine that supports multiple 100MB and 150MB drives and is designed for medium- to large-scale PC networks. 3+Mac extends the 3Server's file, mail, print, tape, and administrative services to Macintosh users on both mixed networks of PCs and Macs and Mac-only networks.

3+Mac supports the Macintosh II, Macintosh SE, and Macintosh Plus using either the built-in AppleTalk port or Ethernet. 3Com manufactures a board for the SE, and Ethernet boards are available for the SE and Plus from third-party vendors such as Kinetics.

Like other high-end network vendors, one of 3Com's corporate strategies is to provide uniform levels of client services to PC, Macintosh, and other major workstation types. 3Com's product philosophy is aligned with the needs of organizations grappling with the problems of multivendor configurations. In such environments, workstation choice often is based on personal preference of user interface or immediate application requirements. In the long term, however, information system managers and network supervisors must deal with the complex connectivity and interoperability concerns created by mixed workstation networks.

As an early entrant into the Mac networking market, 3Com was including an AppleTalk port as a standard feature on its Ethernet-based servers by 1986. EtherMac was supported by the EtherSeries operating system, the forerunner to 3+Share. Following the release of the IBM PC Network and Microsoft's OEM version, MS-NET, 3Com redesigned its software to support the new standards. 3+Share uses the MS-NET redirector and server message block (SMB) protocol. 3+Share and 3+Mac now replace EtherSeries and EtherMac.

According to the market research firm DataQuest, 3Com held approximately 15 percent of the PC LAN market in 1987. Statistics for 3Com's Macintosh market share were not available, but some idea of the demand for Mac support can be gauged by a 3Com-supplied figure indicating that about one-third of all 3Servers shipped to date (an estimated 12,000) are configured with Mac software. Exactly how many of these servers currently support Macs and the average number of Macs per node is difficult to estimate.

The company promotes 3+Mac as a higher-performance alternative to AppleShare, Apple's own file-server system, and Sun Microsystems' TOPS network. AppleShare uses a dedicated Mac as its file server, linking computers with its twisted-pair LocalTalk media or third-party Ethernet cards. TOPS is a peer-to-peer network for PCs and Macs; stations on a peer network can act as both client and server—no one computer need be dedicated as the file server. One capability TOPS provides that 3+Mac does not is Epson-to-PostScript translation for PCs printing to Apple LaserWriters.

CLICKING ON SERVICES

3+ for Macintosh extends the Mac electronic desktop environment to include the distributed resources of PC networks. The Mac's mouse and icon interface is quite effective for rapid manipulation of local objects such as files, file folders (directories), printers, and modems. Moving, copying, or deleting files, for example, takes a fraction of the time it does with the DOS command-line interface. The network extensions of 3+Mac are close enough to the Mac's native interface that the user can easily lose track of whether objects are local or remote.

3Com has created several new icons for network objects, such as users, groups, mailboxes, and aliases (nicknames). Macs access the 3Server in the same way they access the AppleShare file-server system. Folders and files can be saved to the server and

ILLUSTRATION • NED SHATZER

printed to shared LaserWriters or other PostScript-compatible printers.

Mac folders stored on the 3Server appear as DOS directories, and PC users are thus able to access them. Mac users can access files and directories created by PC users, and Mac applications that understand PC file formats can open files created by PC users with PC software. For example, a Mac running Microsoft Excel can open files in Lotus 1-2-3.

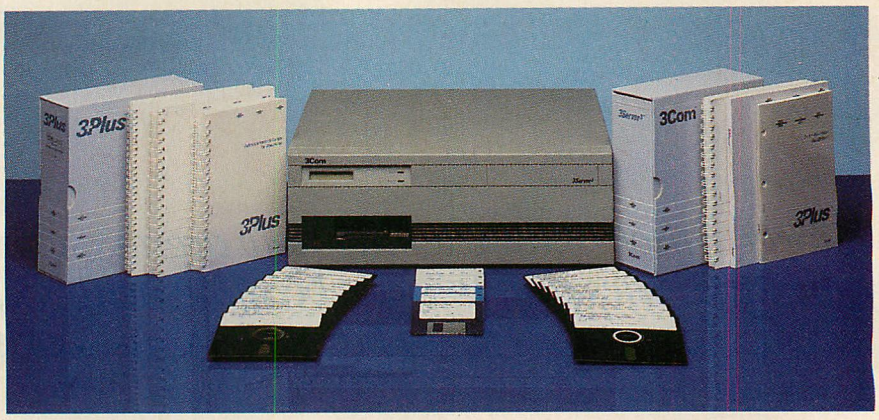
Although the basic Mac services work well, many of 3Com's PC services are not yet available to Mac clients, including remote dial-in, 3270 gateways, modem sharing, and routing to remote networks via 3Com's low-speed links.

3+File. The user installs the 3+Mac file and print service files in the Mac's system folder with a simple copy operation from the 3Com distribution diskette. The Mac's system folder holds the files that make up the Mac operating system, its shell (the Finder), and other utilities. When the Mac boots, it loads the RAM-resident portions of the system, including 3+Mac routines, from the system folder into memory.

Once the 3+Mac files are installed and loaded, the 3Server is accessed through the Mac's built-in LocalTalk port. If Ethernet is required, a board is installed and additional drivers are loaded. The memory-resident portions of 3+Mac occupy a little less than 115KB of RAM, including an Ethernet driver. This would be excessive for a PC network interface but should not present a problem for Macs, which now ship with at least 1MB of RAM and are populated with 4MB or more of addressable memory.

The File icon represents the 3+Mac file services, which include a network-management utility called Network Window, drivers for 3Com's Xerox Network System (XNS) protocol stack, and an external file system that is the Apple equivalent of the MS-NET redirector in the PC network environment. The Mac operating system passes calls to the external system when it determines they are for external network volumes. When the external system receives requests, it translates them into the SMB protocol and passes them to the XNS network software for routing to the server.

A Mac user logs into a 3Server with the Apple Chooser utility, accessed from the accessory menu on the extreme left-hand side of the Mac's pull-down menu bar. The login function is selected by clicking the mouse on the Login button as in photo 1. After a user name and password are entered, the Network Window appears. It presents the standard Mac dialog box to let users establish their network environment by linking to resources on the server. The dialog box provides a hierarchical view of the file system, allowing quick access to any folder on the 3Server; the Mac user links to file folders by highlighting the folder's name and clicking on the link button.



The current version of 3+ for Macintosh runs on 3Com's dedicated server, the 3Server Model 3S/200 shown in this photo. The ample documentation provided in the 3+ for Macintosh package is divided into administrator and user manuals.

When linked, folders on the server appear as icons on the Mac desktop just as an additional disk drive would. A user's configuration can be saved from the Network Window with the Quick-Start feature. The saved configuration is regenerated each time the Mac is powered up, eliminating the need for the Mac user to perform the logins and links every time.

A new 3+Mac network user is assigned a home folder on the 3Server—the equivalent of a home directory on a DOS network. The (Mac-based) administrator enters a user's name, home folder, and other account details. The user can create any number of new folders in the home folder and copy files from local or remote disks to these folders.

Through the Network Window, a user can share network folders with other users. As shown in photo 2, the user assigns a shared folder a *share name*, which identifies it to other users, and an optional password that must be supplied each time the folder is linked. Access rights for shared folders include read-only, write-only, read/write, read/write/create, write/create, shareable, or private.

Multiple users can access folders concurrently, making multiuser applications possible. Files in shared folders with any type of write access are susceptible to data corruption if applications do not coordinate updates. This is also the case for folders given shareable access rights, which allow all types of operations (read, write, create) by multiple users.

Any user can create subfolders in folders with shareable rights. Those folders shared with read-only rights can be read, but not altered, by other Mac users on the network. Read-only folders are a good way for 3+Mac users to make their files available to other users without fear of data corruption. Folders with private rights can be accessed only by their creator.

When a 3+Mac user logs in and links shared and/or private folders, applications can be launched with a double click of the mouse from local drives or the 3Server. Files or entire folders can be moved or copied freely among local and network drives with only one restriction. Folders or applications cannot be moved from a network volume to the desktop directly; they can, however, be moved to the desktop after being copied to a local folder (on a local drive). The net effect of this restriction is that applications on network volumes cannot be launched from the desktop—they can be launched only after opening a network folder. This restriction is necessary in part because a file dragged from a shared folder to the desktop would not be accessible to other users.

Once a 3+Mac session is finished, the Mac can be shut down immediately from the Special selection on the menu bar at the top of the Mac screen—without logging out or unlinking network folders. The 3+Mac software takes care of this housekeeping chore.

3+Print. Like the file services, the 3+Mac print service files are copied to the system folder during installation and have their own icon, called

3+Print. The 3+Print file includes a LaserWriter driver and works very much like the native Mac printing service. A Mac application outputs data to the printer with QuickDraw calls in much the same way it draws the Mac screens. When an application prints, it makes calls to Apple's ROM-based Print Manager. The Print Manager accepts these data and directs them to the driver for the active printer. The driver converts the QuickDraw calls to a format acceptable to the printer, which could be an ImageWriter, a LaserWriter, or other Apple-compatible device.

With 3+ for Macintosh, network printers are selected from Apple Chooser, just as local printers are. When a network printer is selected, the 3+Print driver becomes the active driver and converts QuickDraw format data into PostScript format for the LaserWriters on the 3Server. Print jobs can be directed to network printers from within applications or from the File selection of the pull-down menu. Print configurations such as paper source and page range also are set from the menu bar and work interchangeably with 3+Mac network printers and local printers.

3+Mac supports all PostScript printers that work with Apple's standard LaserWriter driver as spooled serial printers connected to the 3Server. Once spooled, the print job is handled by the 3Server, freeing the Mac for application tasks. Printers interface with serial ports on the 3Server at 9,600 bits per second (bps). Housekeeping, such as printer initialization, is handled automatically. 3+Mac does not support spooling from the 3Server to a LaserWriter from the LocalTalk port, but 3+Mac clients on LocalTalk can print directly to LocalTalk-based printers.

As with the file services, the 3+Mac Quick-Start feature is used to select a network printer to be linked to automatically when the Mac boots. The 3Server's print queue can be viewed from the Apple Chooser (screen shown in photo 3), which includes a list of the jobs on the queue and each job's owner, size, and status. 3+Mac users can delete jobs, defer jobs for later printing, and change form type and job priorities.

3+Mail. 3Com's electronic mail (E-mail) product, 3+Mail, is a full-featured, store-and-forward system that provides mail services to PC and Mac clients anywhere on an internetwork. Sold as an add-on product to 3+Mac, it installs on the Mac and the 3Server as an extra service. Mac users of 3+Mail have available all the functions that PC users have. Mail messages and attachments can be sent to any local or remote user registered in the name service. Attachments can be ASCII files, application data files, or binary files of any kind. A Mac user attaches files to a message with the dialog box window, by scrolling through any folder to which the user has rights and making attachments.

Unlike other LAN E-mail systems—which keep all mail in a central post office file through which a PC mail program searches for the user's mail—3Com uses a mail-service process in the 3Server. When mail is sent to a user, the application program on the client station sends the message to the 3+Mail process on the file server. The mail service then looks in the name-service database and places the message in the correct mailbox.

3Com has created several excellent icons for 3+Mail, including different symbols for read and unread mail, registered mail, and attachments. The icons make editing, sending, and reading mail quick and straightforward. Like many Mac applications, the mail program is well done and should require little learning time. Mac users with the MultiFinder window system can run 3+Mail as a pop-up application.

When users receive mail, they are notified of its arrival by a desktop accessory called 3+Mail Minder, which notifies them of mail receipt via a pop-up window or by sounding a tone. The interval between mail notification reminders can be set to 1 minute, 5 minutes, or 15 minutes.

3+Backup. 3+Mac users configure and initiate backup sessions to the tape drive built into the 3Server. The server supports 60MB and 150MB tape drives—well matched to the 100MB and 150MB hard disks on the server. A 3Server with a tape drive can back up data from its own disk drives or disk drives on other 3Servers. Data backed up on one server can be restored to other servers, with some restrictions. Mac users can execute incremental or

SPECIFICATIONS AND PRICES

Client hardware. Macintosh II, Macintosh SE, or Macintosh Plus.
Server hardware. 3Com 3Server Model 3S/20*x*.
Server processor. 80186, using real mode only.
Server operating system. DOS with 3Com extensions.
Resource management. Centralized.
Name-service type. Centralized.
Client-server protocols. Microsoft server message block (SMB).
Transport protocol. Sequenced Packet Protocol (SPP), which is a Xerox Network System (XNS) derivative.
Network protocol. Internet Datagram Protocol (IDP), which is also an XNS derivative.
Media-access methods. Macs access media with Ethernet or AppleTalk; 3Servers may be connected using Ethernet or IBM Token-Ring.
Cable systems. Thick Ethernet, thin Ethernet, Apple LocalTalk cable system, or telephone twisted-pair cable.
Mac memory requirements. 115KB.
Maximum memory (3S/20*x*). 3MB.
Maximum number of printers. Two parallel, five serial (not available with some configurations).
Maximum number of disks. Nine (using SCSI controller).
Maximum server network channels. Three (Token-Ring, Ethernet, and AppleTalk).
Maximum server storage. 900MB.
Tape-drive capacities. 60 or 150MB.
Disk-drive capacities. 100 or 150MB.
Hardware pricing.
3Server 3S/200 (80186, 2MB memory, 100MB hard-disk drive): $7,995
3Server 3S/201 (same features as the 3S/200, except with a 60MB tape drive): $9,745
3Server 3S/202 (same features as the 3S/200, except with a 150MB tape drive): $9,995
1MB expansion memory card for 3Server: $1,795
Expansion cabinet with 150MB hard-disk drive: $5,295
Optional 150MB add-in drive: $3,995
Expansion cabinet with 100MB hard-disk drive: $3,995
Optional 100MB add-in drive: $2,495
150MB tape drive for 3Server: $2,395
Port expansion card: $525
TokenLink card for server: $1,295
3Station: $1,895
EtherLink card: $495
EtherLink II card: $495
EtherLink Plus: $895
EtherLink/NB for Macintosh II: $595
Software pricing.
3+ for Macintosh: $495
3+Route: $1,250
3+Mail 1.3 (server): $595
3+Mail for Macintosh (client): $595
3+Reach/MCI (MCI gateway for 3+Mail): $595

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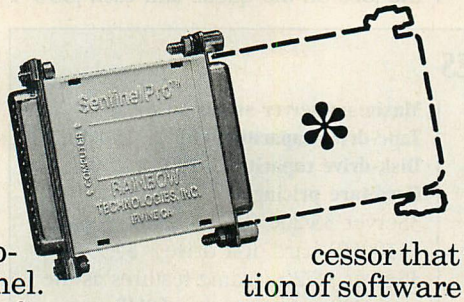

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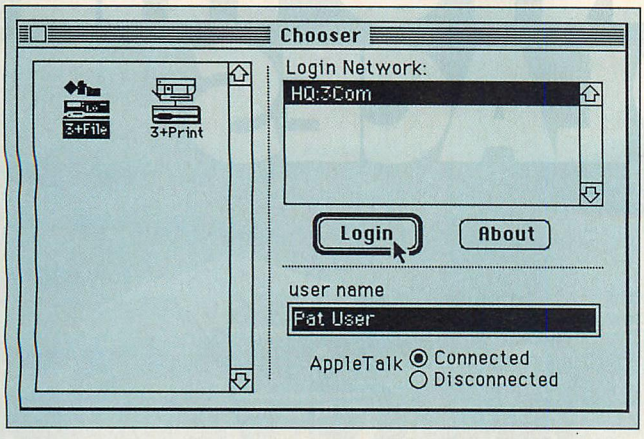
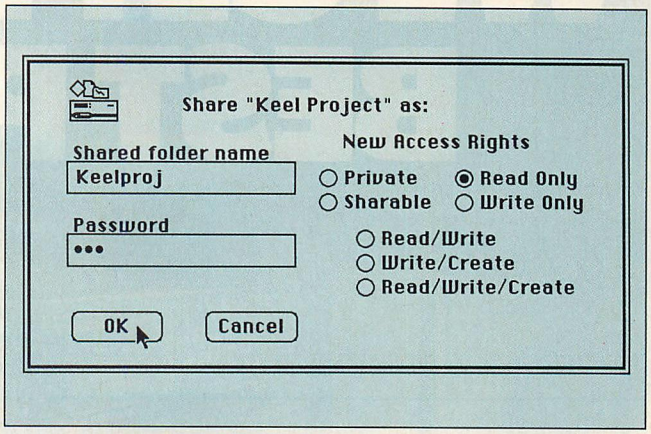
CIRCLE NO. 157 ON READER SERVICE CARD

PHOTO 1: *3+ for Macintosh Login Screen*



Mac users access 3+File and 3+Print management utilities from the Apple Chooser menu. Clicking the mouse on the 3+File icon brings up this login screen, which lists servers.

PHOTO 2: *Folder-sharing Facility*



Folders are shared from this screen with mouse and keyboard input. Shared rights each have a "mouse button." Here, Read Only rights are enabled for the Keelproj folder.

full backups of network volumes. Backups take place immediately or on a prescheduled basis. Once scheduled, backups require no additional interaction with the Mac workstation because the tape backup routine runs as an independent process on the 3Server.

This server-based backup process is an excellent approach to network archiving. There are many difficulties inherent to backing up Mac files and folders on DOS drives, however, and 3+Backup needs much improvement before it can be considered a full-feature tape service. For example, the automatic backup feature allows only one session per day. Also, the service does not back up open files in read-only directories as do some PC tape products. Further, only entire directories, not individual Mac files, can be restored.

3+Name. The 3+ for Macintosh name service lets users access network objects with familiar names, regardless of their location. The name service shields users from complex and changing network addresses, thus enabling consistent access procedures. Each name consists of three parts, separated by colons:

Name : Domain : Organization

The total length may not exceed a combination of 58 characters, including spaces, with the name portion limited to 40 characters, and domain and organization limited to 20 each. Each network object, such as a user, group, printer, or shared directory, has a unique name—for example,

Jane Smith : Headquarters : XYZ Corp.

or

LaserWriter : Art Department : XYZ Corp.

When a user accesses a resource, it is referred to by its name, and no knowledge of the network's physical connection is required. Resources in a user's default domain can be accessed with just the first part of the name. Objects also may be assigned nicknames called *aliases,* so users do not need to remember long names.

3Com has enhanced its name service in the Mac environment with name-service icons. Icons are especially useful here because they give the user a standard set of visual objects to represent network entities. 3+Mac often juxtaposes the name-service icon with the textual name of a network object in its management utilities to assist in identification.

Administration. Administrative functions are the least developed of the 3+Mac services. 3Com provides a utility for making user accounts (see photo 4), but does not have a full complement of advanced system management features. The name-service area, in particular, needs improvement. For example, once a network domain is created, it cannot be renamed; a domain name can be changed only by deleting all of its users and resources and building a new domain. This inability to modify domain names may be inconvenient for an organization that makes frequent departmental changes.

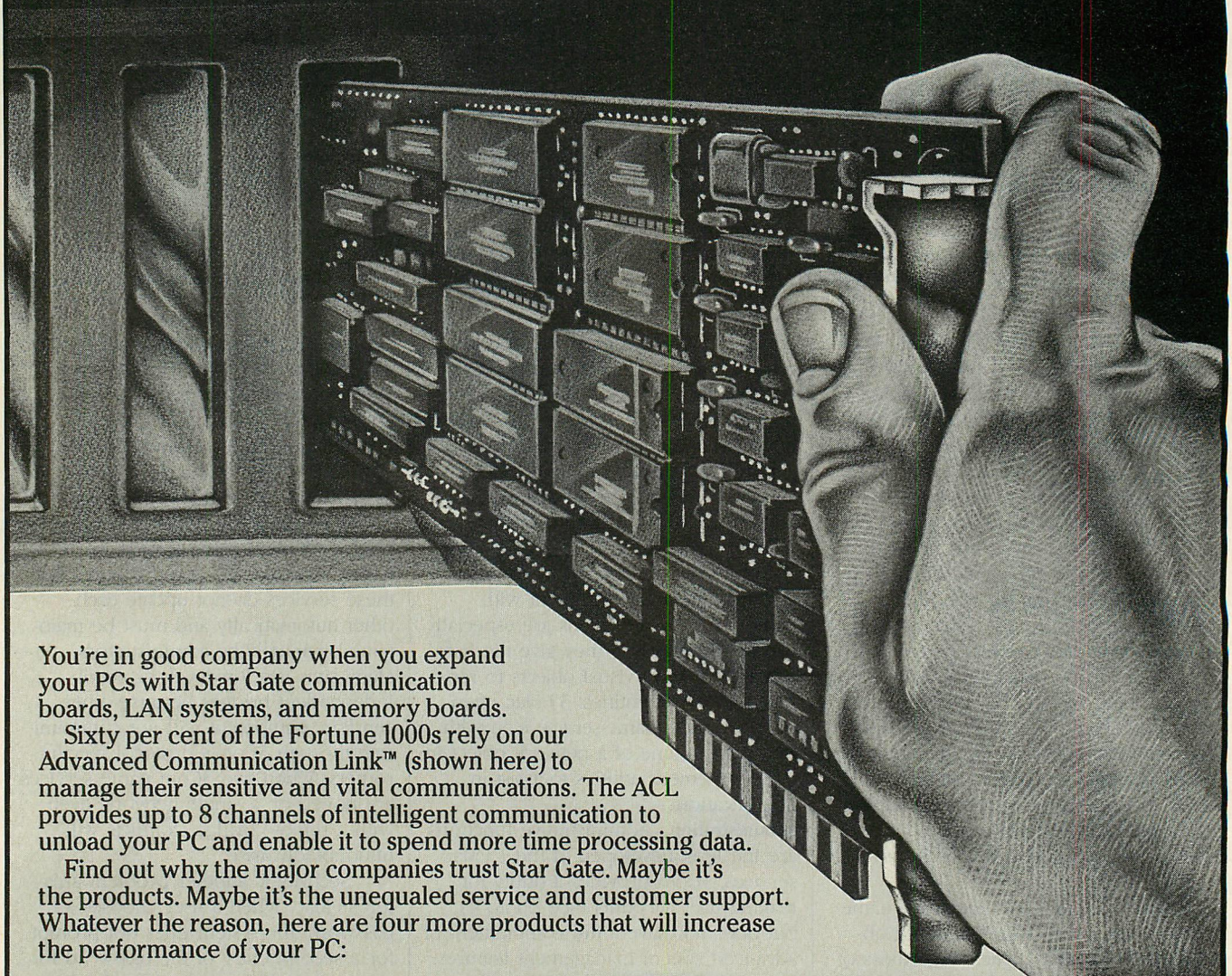
The 3Com name service is required on only one server in a multiserver network. Its highly centralized nature is a drawback at many sites where large Ethernets are built with low-level bridges. These bridges can create enormous Ethernets by electrically segmenting networks and filtering packets between local segments. On a large network such as this, which often encompasses an entire building, a single name service represents a vulnerable point of failure.

Other vendors approach name service in a distributed fashion that automatically updates names maintained on every major file server. 3Com supports additional name servers on networks separated by 3Com routers, but these services do not update each other automatically and must be maintained manually by administrators. Many sites use low-level, protocol-independent bridges because other vendors' equipment will not communicate through 3Com's protocol-specific routers. When two 3Com name services are united on a single network, even with a remote bridge, conflicts will undoubtedly arise.

Security is another problem area for 3+Mac. When a user chooses a password, the system does not prompt for a second entry of the password for verification. This can lead to problems if an incorrect key has been pressed, because the user cannot be assured that the intended password has been entered. Users who enter an incorrect (nonmatching) password lose rights to the system without help from the administrator.

Some administrative deficiencies in 3+Mac stem from the MS-NET architecture upon which it is based. MS-NET segments users' home work areas into isolated logical root directories that cannot be viewed as a whole by a network client. As a result, when a user account is deleted without deleting its home folder, the folder still exists but is inaccessible to any user. 3+Mac warns administrators not to attempt

WE GET INTO THE BEST PLACES



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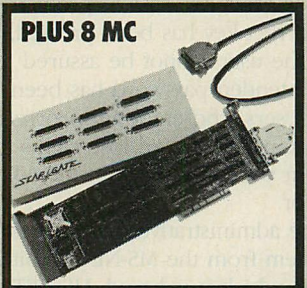

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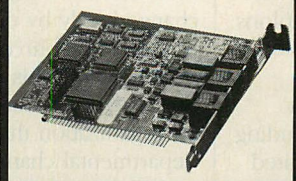

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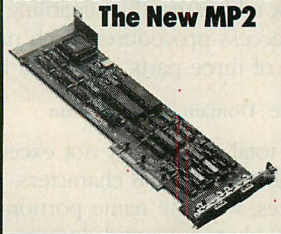

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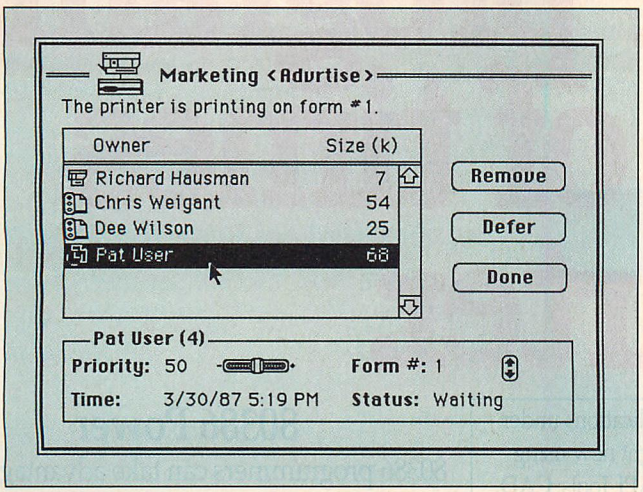
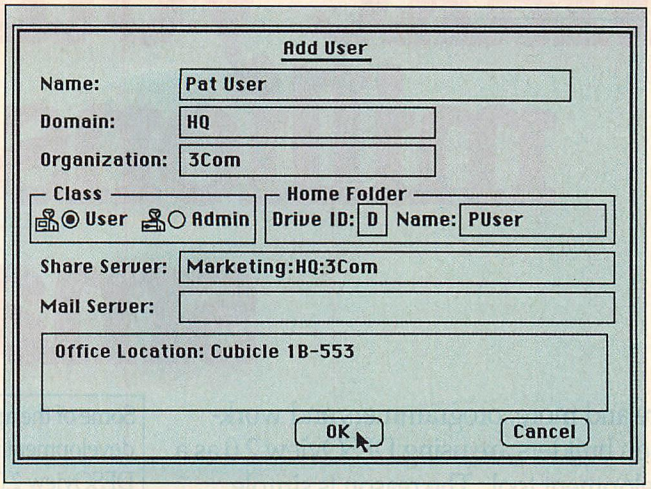
PHOTO 3: ***3+for Macintosh Print Service***



The print queue status box displays the status of four current print jobs. Icons to the left of each job indicate status such as printing, waiting to print, and printer error.

PHOTO 4: ***User Administration Screen***



Administrative functions can be performed by Mac-based users. Each user is assigned a home folder and default server. Class of user is selected with mouse buttons.

deleting a user without purging the user's folders.

MS-NET does not provide the facility for centrally managed user security as the Banyan and Novell systems do. Surprisingly, 3Com does not use its name service to maintain profiles of user rights to system resources, such as files, directories, and printers. This lack of centralized user profiles means that each time a secure resource is linked, the user must supply a password. This approach is inconvenient for users who access numerous resources. Many MS-NET systems get around the password problem by not assigning passwords, embedding them in batch files or, in the case of 3+ for Macintosh, Quick-Start files. Neither of these approaches is acceptable for sites with tight security requirements.

The MS-NET security system is a throwback to earlier distributed network management philosophies that were feasible only for small, underutilized networks. A system in which the users assign and manage passwords for large numbers of system resources is not sufficient for many larger sites and business environments. When a user successfully logs in, the full complement of resources should be available without additional passwords.

In its current implementation, the 3+Mac Quick-Start feature automatically enters all of a user's passwords, or none of them, during boot-up. A better method would be to force the user to enter the login password during start-up and then have the passwords entered automatically for linked network directories.

For some 3+Mac system-management functions, the administrator must log in with the special login name of Server-User. This account lets the administrator create public directories and manage printer links and passwords. It would be more convenient for the administrator if all common system management functions could be executed under a login name.

INTERNAL COMPONENTS

3Com relies on its 3Server to provide network services to Macs under 3+Mac. The 3Server software comprises five major components: multitasking process manager, network-optimized file system, XNS communications protocols, MS-DOS and device drivers, and server-based processes such as 3+Share, 3+Mail, and 3+Backup. DOS is used mainly to load the 3Server's system software. Once the file system, process manager, and XNS stack are loaded, DOS has little use. Some DOS handlers, such as the time and date function, are used, but most of the code in the server is 3Com's.

The 3Server software components reside in the first 896KB of its 1MB of RAM—3Com can exploit more than the standard 640KB because the 3Server needs no video memory (because it has no monitor) and has no devices, such as EGA, 3270, or network boards, that require high memory. The remaining 128KB of conventional memory between 896KB and 1,024KB is divided equally between the 3Com ROM BIOS and accessing the expanded memory specification (EMS) file-caching system that resides in the 1MB or 2MB of expanded memory. The 64KB for caching consists of four 16KB page frames.

I/O requests to the 3Server originating from network clients are queued by the process manager, make their file system calls, and "go to sleep" while disk accesses take place. The process manager is nonpreemptive, relying on the good behavior of the server processes; it occupies approximately 4KB of RAM and is loaded as a device driver. The process manager maintains a run of pending processes and stores stack and register data for the processes it manages. The manager recognizes different priorities for disk requests, store-and-forward mail routines, print spooling, and other processes.

3Com's file system, called CIOSYS for concurrent I/O system, gives the 3Server substantial performance gains over single-tasking, DOS-only servers. CIOSYS loads as a terminate-and-stay-resident (TSR) program and consists of a reentrant function library that supports multiple I/O processes concurrently. Although the DOS file-allocation tables (FATs) and directory tables are present on the 3Server, they are not used by CIOSYS, which maintains and caches its own FATs and directories. Disk accesses are sorted by location on the disk, permitting "elevator" seeking by disk heads.

Mac users can point to a data file with the mouse and click twice to load both the file and the application program that created it. Consequently, Mac files must carry more data than DOS files. Mac files include *creator* information about the application that created them and the type of file they are, as

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specified by the application. The file type is similar to DOS application extensions, such as .WK1 for Lotus 1-2-3 files. Additional functions have been added to CIOSYS for 3+Mac to accommodate the differences between the PC and Mac file structures. Mapping the Mac file system to the DOS file system on the 3Server presents challenges, and CIOSYS handles them well.

Mac files get much of their enhanced functionality from a structure that splits a file into a *data fork*, which stores a file's data, and a *resource fork*, which stores program code and application specifics such as fonts, icons, and menus. Application files, system files, and data files can use resource forks, data forks, or both in the Mac file system. DOS files have no equivalent to forks, which complicates the translation of Mac files to DOS files and vice versa.

CIOSYS stores the Mac resource fork in a separate file and generates a generic resource fork for files created by PCs to be accessed by Macs in shared folders on the 3Server. CIOSYS has a generic document icon labeled "PC" for files created by PCs. Under CIOSYS, Mac folders on network volumes are actually DOS directories and can be viewed as such by PC clients. Both PC and Mac users can access data files that are in a common format, such as text files, Microsoft Excel spreadsheets, or WordPerfect documents (note that WordPerfect now has a Mac version). PC users see only the data fork of Mac files; the resource fork is stored as a hidden file.

CIOSYS creates a small information file for every Mac folder stored on the 3Server. This supplemental file maintains data that the Mac file system needs and that the DOS file system cannot store internally, such as longer Mac file names, file creator, and file type. Every Mac folder on the 3Server has a corresponding directory also on the 3Server. The folder-information file is stored in each DOS directory that corresponds to a folder.

The file forks and supplemental folder files can cause problems for tape restores, among other functions. The 3+Mac tape system can restore entire folders only to the 3Server; restoring individual files would lead to inconsistencies between forks and the folder's supplemental information file. For this reason, 3+Mac tape restores cannot overwrite existing directories and thus must target empty folders.

The Mac file system supports file names up to 31 characters long and can contain spaces and other printable characters (except for the colon, which serves as a delimiter). CIOSYS stores the Mac file names in the supplemental file and translates them into unique PC file names for compatibility with the DOS directories on the 3Server. Under this system, spaces become underscores and sequential numbers can be appended to resolve any file-name redundancies. Thus, PC users see the eight-character DOS file names and extensions they are used to, while Mac users see the full Mac file name.

3+ for Macintosh translates the Mac creator and file type attributes into DOS format, which greatly simplifies file sharing between PC and Mac applications. The administrator can define mappings between creator and type combinations and DOS file extensions when the 3+Mac service is set up. For example, Aldus PageMaker Mac files have a creator of ALD2 and are type PUBF. These files can be converted to a DOS file extension of PUB, which is how the PC version of PageMaker saves files. 3Com also has a utility for DOS clients called MACDIR, which displays full Mac file names, fork names, creator, and file type.

Under CIOSYS, Macintosh folders on network volumes are actually DOS directories and can be viewed as such by PC clients.

3+Mac translates AppleShare sharing mode and byte-range locking calls to the appropriate DOS 3.1 functions, so Macs can open files in various modes and lock records and/or files on the server. PCs and Macs can even access the same files simultaneously with complete locking protection if the application programs are written to the appropriate standards.

3Com has created additional SMB messages to handle those features of the Mac file system, such as resource forks, that have no counterpart in the PC world. The 3+Mac service on the file server interprets these additional messages and performs the appropriate action. When a PC renames a Mac file, DOS renames only the data fork of the file; the 3+Mac service interrupts the request and renames the resource fork as well. The only time this process breaks down is when a PC user copies a Mac file. Only the data fork is copied, and because no corresponding resource fork is present, Mac users cannot use the copied file.

TOPOLOGY AND PROTOCOLS

The 3Com protocol suite is called MINDS, for MS-DOS internal network driver scheme. MINDS is a layered communications architecture that permits individual components to be modified or replaced. For example, the MINDS XNS network and transport layers can be run on top of Ethernet or Token-Ring data link layers. On the 3Server side, 3Com's XNS protocol stack components are loaded into low memory as DOS device drivers specified in a CONFIG.SYS file on the boot volume of the 3Server. On the Mac side, a combination of the 3Com XNS stack and low-level AppleTalk protocols is used. (To avoid confusion, AppleTalk is Apple's protocol suite and LocalTalk is its twisted-pair cable system.)

Mac clients accessing 3Servers with LocalTalk links use XNS for the upper layers, such as network and transport. AppleTalk link access protocol (ALAP) is used to access the LocalTalk media. Macs accessing the 3Server with Ethernet also use XNS for the upper protocols but load an additional EtherTalk driver to drive the Ethernet card.

Both LocalTalk and Ethernet clients support datagram delivery protocol (DDP), an Apple network-layer routing component. Some third-party Mac network products use their own network and transport protocols; thus, support for Apple's high-level protocols does not guarantee interoperability. DDP assists 3+Mac clients with some third-party bridges available for Macs.

The basic configuration for 3+Mac is a string of Macs connected with the built-in LocalTalk to the 3Server. LocalTalk twisted-pair cables are available from Apple in varying sizes. Third-party products such as Farallon Computing's PhoneNet allow LocalTalk to run on telephone system wires. Macs on a LocalTalk tributary communicate with the server at speeds of less than 300 kilobits per second (Kbps). These Macs can print to either LocalTalk- or 3Server-based LaserWriters. LocalTalk-based Macs also can route through the 3Server and access files on other 3Servers running 3+Mac.

Mac clients on Ethernet can use the services available on the 3Server to which they are attached but not on other 3Servers on the same network.

"How to protect your software by letting people copy it."

By Dick Erett, President of Software Security

Inventor and entrepreneur, Dick Erett, explains his company's view on the protection of intellectual property.

"A crucial point that even sophisticated software development companies and the trade press seem to be missing or ignoring is this:

Software protection must be understood to be a distinctively different concept from that commonly referred to as copy protection.

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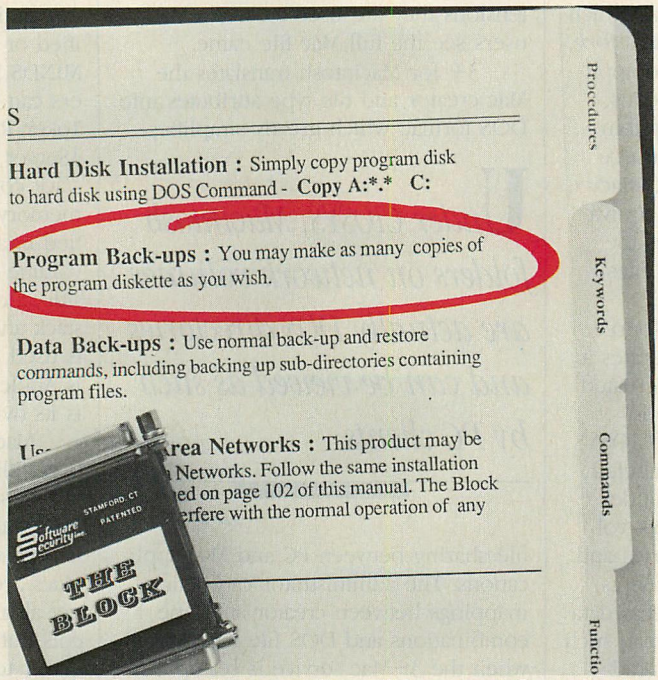

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This is because 3Com has not yet implemented the necessary routing protocols for its Ethernet Mac clients. More importantly, both Ethernet and LocalTalk clients are able to send mail to any other client on any server on the network through 3+Mail.

AppleShare client software can be loaded with 3+Mac in the same station at the same time, and folders can be linked to volumes on both 3Servers and AppleShare servers. AppleShare networks often use third-party products for internetworking, and Macs cannot always communicate through these products to 3Servers.

Large Mac networks must employ third-party components to supplement the connectivity products available from Apple. One of the most popular of these products is the InterBridge from Hayes (Atlanta, Georgia), a combination of hardware and software products for bridging AppleTalk networks. Macs on separate AppleTalk networks can access AppleShare servers and LaserWriters through the InterBridge. One configuration of this device includes a modem for connection of physically remote networks. Transmission speeds are equal to that of AppleTalk (230 Kbps) for local bridges and up to 9,600 bps for remote bridges. The InterBridge has built-in network management functions that support diagnostics, traffic monitoring, and dynamic routing. A similar AppleTalk bridge, with enhanced communication features such as dial-in, is manufactured by Solana Electronics of San Diego, California.

The FastPath gateway from Kinetics Inc. (Walnut Creek, California) also supports AppleTalk protocols. FastPath connects Macs on AppleTalk networks to Ethernet. FastPath can connect a number of work-group-oriented AppleTalk "tributaries" with an Ethernet backbone. Another Mac connectivity option is the DuPont (New Cumberland, Pennsylvania) line of fiber-optic products for AppleTalk networks. DuPont's fiber-optic networks can extend Mac networks for thousands of feet and can be configured in star or daisy-chain topologies. Fiber-optic media connect to the Mac with a converter unit for each Mac and LaserWriter.

RELIABLE 3SERVER

3Com has excelled in network hardware manufacturing. The design and execution of its servers and network boards is consistently high. The 3Server is a well-engineered network device that, once configured, provides reliable operation with little maintenance.

The 3S/200 3Server comes standard with 2MB of memory, expandable to 3MB. It has one serial port and one parallel port and intelligent small computer system interfaces (SCSI) for both disk and tape drives. Four serial ports and one parallel printer port can be added with an optional port expansion card. Because the 3S/200 has only one expansion slot, users may install the port expansion board or a Token-Ring connection, but not both. The Token-Ring board has two additional serial ports, but one of the serial ports on either add-on board must be disabled if the server's AppleTalk port is to be used. Consequently, the Token-Ring board effectively adds only one free serial port if AppleTalk is used.

OS/2 will give 3Com more memory for its server-based processes by running on 80286 or 80386 processors in protected mode.

The 3Com 3Server Model 3S/200 does not include a diskette drive. The 3Server requires either a Token-Ring- or Ethernet-connected PC running as a console to use 3Com's installation and configuration software. Thus, Macintosh-only networks require at least intermittent use of a PC. 3Com could assist network administrators by supporting a diskette drive on the 3Server or distributing system software on tape cartridges, as Banyan does with its VINES network.

Most 3+ sites use 3Com's original 3Server3 or the 3S/200. Increasingly, however, clients are choosing 3Com's best-performing server, the 80386-based 3S/400. It runs at 16 MHz and features AT-style expansion slots that can accommodate third-party products such as AST multiport cards. (3+Mac ran only on the 3S/200 at the time of this writing, but is expected to be available on the 3S/400 later this year.)

Server-resident processes are central to the architecture of the 3Server. Processes that support E-mail, name service, backup, and so on, benefit greatly when off-loaded from workstations to the dependable 3Server environment. The most significant drawback to these processes is the amount of memory required in the server.

3Server software is limited to less than 1MB of memory running in a quasi-DOS environment in real mode. Fitting all the 3Com services onto a single 3Server is impossible with this memory limitation. This is particularly true for networks that require tape backup, diskless workstations, Macs, and other services requiring server processes. This memory limit is imposed by the 80186, which has the same 1MB address space as the 8086 and lacks support for protected-mode addressing, as does DOS.

An 80286-based 3Server would have enabled 3Com to use more memory for the services and caches, eliminating the need for multiple servers in some situations. With this approach, DOS would have to be eliminated to achieve the protected mode required for addressing memory above 1MB. Without DOS, 3Com would be put in the position of providing its own proprietary operating system—as are Novell and Banyan.

Given the DOS constraints, the significance to 3Com of the upcoming OS/2 LAN Manager and its large memory workspaces becomes apparent. 3Com's version of LAN Manager, 3+Open, is promised for delivery later this year. 3+Open should free 3Com from its current memory limits and enable all network services to run on one server. Unfortunately, all 3Com 80186 servers will require an expensive motherboard replacement to run OS/2 and 3+Open. The 3S/400 should have no problem running 3+Open, and 3Com promises a graceful migration path from the current 3Server software to 3+Open for 3S/400 servers.

Memory-related concerns make configuring server processes a challenge for the administrator who must select which services to put on each server, balancing performance against hardware and memory requirements. 3Server system software has an enormous number of adjustable parameters, such as the number of diskless workstations on the network and the number of users simultaneously in mail. These parameters affect the network's performance and the amount of memory available in the server for other services. In its current implementation, the 3Server software is more difficult to bring up and manage than Banyan or Novell server software.

MAC PERFORMANCE CHOICES

The *PC Tech Journal* LAN performance tests examined the application load times for the Macintosh using 3+Mac.

Applications were launched from local diskette drives, local hard disks, and 3Server drives by the Mac II and the Mac SE in Ethernet and AppleTalk environments. Mac performance on 3+Mac was generally good, particularly on Ethernet. The best performance was obtained from local hard disks; the worst from AppleTalk. The Mac SE, for example, was able to load Microsoft Word (350KB) from the 3Server across AppleTalk in an average of 15 seconds. The same application loading from the SE's local hard disk was twice as fast, loading in 7 seconds.

Load times for large applications over AppleTalk can take an excessive amount of time. Aldus PageMaker (910KB) took more than 45 seconds to load on the Mac SE through AppleTalk. By comparison, PageMaker loaded from the local hard disk on the same machine in 14.2 seconds. AppleTalk's 230-Kbps speed does not compare well with the fast hard drives contained in the Mac SE and Mac II.

Operations not bound by slow peripherals were 50- to 100-percent faster on the 68020-based Mac II than the 68000-based SE. The Mac II's 15.6-MHz processor, full 32-bit architecture, and other enhancements translated into better performance, both on the network and locally.

The built-in drives on both Macs performed very well, exceeding performance on Ethernet. The Mac II, for example, could load Microsoft Word in 3.7 seconds from its local hard disk, but took nearly 6 seconds for the same operation through Ethernet to the 3Server drive. Long, sequential operations, such as file loads, cannot be cached in the server. Ethernet could be expected to perform better for cached file operations.

The variation in performance turned in by assorted Apple workstations and network types was considerable. This can create extra work for persons evaluating or planning Mac-based networks. Performance-sensitive applications should be tested for the specific configuration on which they are intended to run.

AppleTalk may be fast enough for users with light- to medium-application throughput requirements. These users should find the performance for login, linking, and launching of network applications such as mail, word processing, and data managers to be quite adequate. On the other hand, users with applications that load the network with long or frequent file I/O or print requests might want to consider Ethernet. As Macintosh processing power and application sophistication increases, Ethernet becomes more appropriate.

3+MAC FORECASTS

The integration of PCs and Macintoshes that is realized with 3+ for Macintosh is excellent, and the translation of Mac files to DOS format for storage on the 3Server works quite well, making the sharing of data between the two types of workstations possible. 3+Mac is a reliable product for a wide range of network applications.

3Com's 3+Mail is particularly useful in uniting PC and Mac clients with the same user for the exchange of mail and any type of attachment. The 3+Mac print services, which provide spooling to the 3Server, should prove a substantial improvement to Mac users familiar only with Apple's native print services. 3+Mac's tape and administrative services leave much room for improvement, but even these deficiencies fall in the natural upgrade path of 3+Mac and do not represent flaws in the primary function of the product.

Other LAN vendors are making efforts to enter the Mac network market, but 3Com has garnered a substantial lead.

Like many products in the LAN industry, 3+ for Macintosh is greatly affected by the turbulence of the operating system and network communications software products that support it. Many areas of concern with 3+Mac are directly related to the 3Server and 3Com's PC network architecture. Large sites with many servers on an extended Ethernet may have problems with the current state of 3Com's name service and internetworking functions. The trend with large Ethernets is to segment with low-level bridges that allow multivendor protocols to pass through. In this environment, the name service should be distributed to any server and globally updated automatically. 3Com's present implementation of a single, centralized server per network is not ideal for large Ethernet sites.

The future of 3+ for Macintosh is closely tied to developments for the 3Server and its system software. The OS/2-based 3+Open should improve 3+Mac and other 3Com services. OS/2 will give 3Com more memory for its server-based processes by running on 286 or 386 processors in protected mode. This environment is just the type needed by 3Com's services, which have been increasingly restricted by DOS.

From this perspective, 3Com has played its cards well in deploying its network technology. Having made the short-term sacrifice of developing its services under DOS to stay in tune with the industry standards set by Microsoft, its server processes should now be able to flourish in the memory-rich, multitasking OS/2 environment. The close relationship that 3Com has with Microsoft and LAN Manager will help to insure this.

Though many enhancements are possible, 3+ for Macintosh proves that it is feasible for Macs and PCs to coexist productively on a common file server. During testing for this review, the efficient user interface of the Mac and the reliable network services of the 3Server demonstrated that they add up to a remarkably powerful combination. The Mac's icon-driven interface encourages experimentation and intuitive learning while at the same time providing easy access to the 3Server's considerable resources.

Other vendors (such as Banyan and Novell) are making efforts to enter the Mac network market, but 3Com has garnered a substantial lead. Whether this lead will ultimately translate into a superior product is not yet clear and will be impossible to determine until later this year or next year, when other vendors' Mac-networking products become available for evaluation.

For sites that already have 3Servers and Macintoshes, interconnection should be a given. For those sites that have Macs and rigorous production applications, the recommendation is to consider 3Com's 3+ for Macintosh and the 3Server. For sites that have no PCs or Macs, users may have a tough decision between the two systems. PCs have a long way to go to catch up with the Macs in some key areas.

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Howard Marks is a New York City-based consultant specializing in LANs. The name of his firm is Networks Are My Life.

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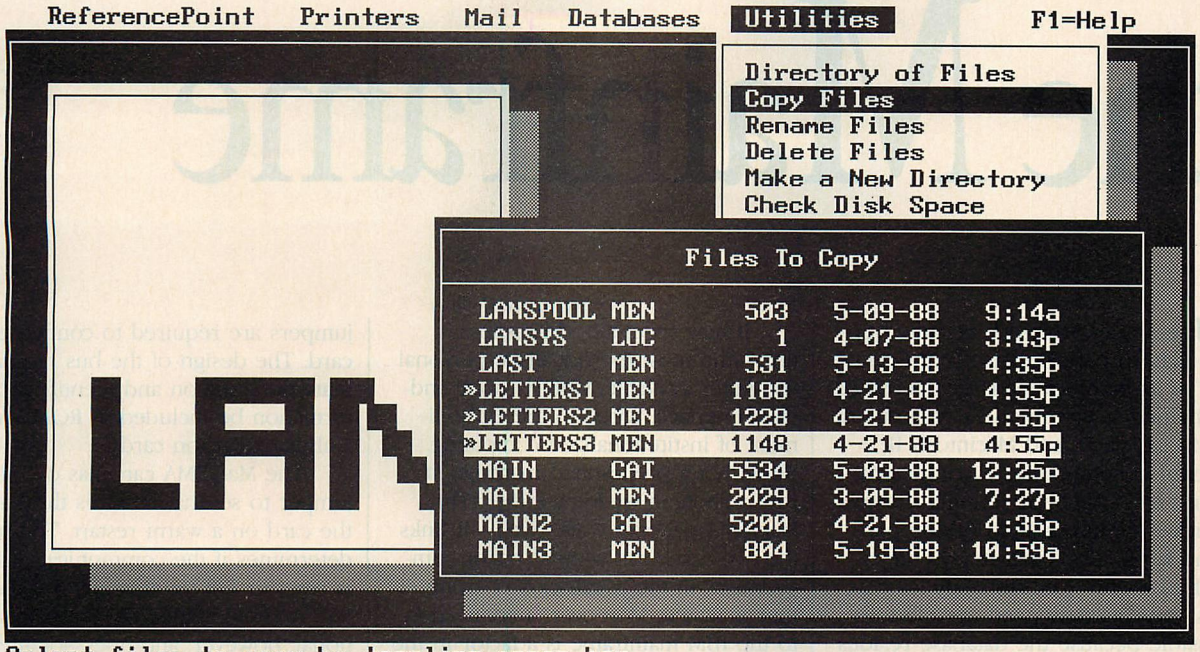

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Multi-user licenses for network versions of popular software can get expensive. As the number of new users and applications grow, so do your costs. Adding an individual license for each user on the net may be safe, but it usually isn't cost effective. Let's face it: not every user runs the same program at the same time. Software metering can take the guesswork out of licensing costs, now. Metering lets administrators set a limit on the total number of concurrent users for any application running under the LAN Shell.

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Macintosh Meets the Mainframe

The Apple Macintosh became popular, in part, because of the allure of its graphics interface. Devoted fans helped spawn the next generation, the Macintosh SE and Macintosh II, powerful general-purpose computers that are even better at running the sophisticated graphics and desktop publishing applications that many companies find useful. Unfortunately for Mac users, the data they need are often inaccessible because the database resides in the corporate mainframe.

That information need not be inaccessible anymore. With MacIRMA hardware and software from Digital Communications Associates Inc. (DCA), Mac users now can connect directly to an IBM 3*x*74 cluster controller sitting in the nearest closet. PC users have had this access for several years through emulators for IBM 3270-type terminals. Emulators help consolidate several functions into one device and usually support data transfers to and from the mainframe. Mac aficionados had to be content with other more indirect means, such as dial-up connections or downloading data from a PC.

MacIRMA is similar to the IRMA package for the PC offered by DCA. Table 1 compares MacIRMA 1.0 and IRMA 2, the latest PC version. Both Mac and PC users can transfer files to and from a mainframe and can copy mainframe screen displays to microcomputer files, to a printer connected directly to the microcomputer, or to a printer connected to the controller. However, MacIRMA is strictly a Mac application and has the same features that made the Mac famous: the mouse, pull-down menus, resizable windows, and copy-and-paste operations.

ILLUSTRATION • NED SHATZER

It may seem an odd combination—the most individualistic personal computer available, with its point-and-click interface, wired to the embodiment of institutionalized computing. While not a predestined marriage, it isn't a shotgun wedding either. The MacIRMA package works well—it links the two machines without major compromises in the usual ways of using either machine. Moreover, a connection to the IBM mainframe is a factor in the corporate acceptance of the Mac.

RIDING THE NUBUS

The Mac II is the most expandable model in the Macintosh line. Unlike previous models, its packaging parallels that of the IBM PC: the keyboard, monitor, and system unit all come as separate pieces. The Mac II system unit can hold six expansion cards (the MacIRMA card uses one slot) and uses Apple's adaptation of the NuBus architecture. The NuBus specification, which is the result of the efforts of an IEEE committee (with input from Apple), began as a design for minicomputers but has been adapted to support microcomputers.

Among other features, NuBus allows for a 32-bit address space, and the bus design is not tied to any specific processor. It allows any card on the bus to assume control of the system, even at system initialization time. Its address space is unreserved for specific processes (address ranges are not dedicated for video pages or CPU areas, for example). Specific address ranges are dedicated to "slot space." Each possible slot has a dedicated 16MB region.

Because each card is assigned an address location based on the slot into which it is installed, no switches or jumpers are required to configure a card. The design of the bus requires that configuration and identification information be included in ROM on the NuBus expansion cards.

The MacIRMA card has only one jumper to set that controls the status of the card on a warm restart. The setting determines if the communications line is reset or left uninterrupted if the system is reset. Setting the jumper is optional, however, and does not affect how the Mac addresses the card.

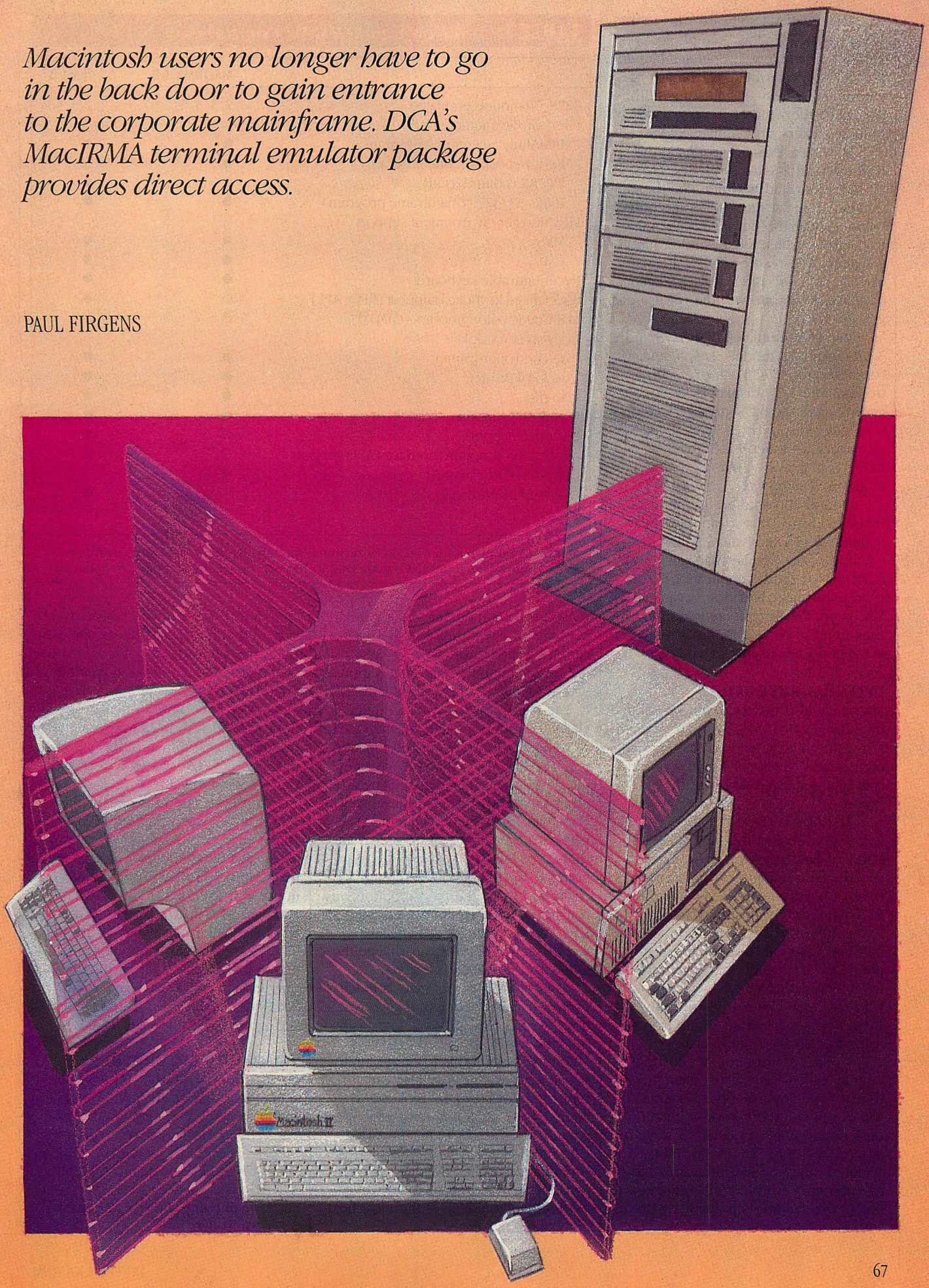
The MacIRMA card is solidly constructed; it has no soldered-on leads or last-minute fixes. Installation is not difficult—a screwdriver opens the cover of the Mac II. MacIRMA software installation is also easy. A user can run the program directly from the diskette, or it can be copied into an appropriate folder on a hard disk. The software is not copy protected, comes on a single 800KB diskette, and uses 192KB of RAM when it runs.

The documentation is generally clear but could be more complete. For example, the manual lists possible error messages but does not discuss possible causes or cures. Fortunately, DCA has a reasonably good support system in place; support received through a toll-free phone number was both helpful and knowledgeable.

MacIRMA diagnostic routines are invoked from a menu included as a standard part of the application. No external programs must be loaded and run. The diagnostics verify that a MacIRMA card is installed and its RAM and microprocessor are working properly, check the data path on its transmitter and receiver, and make sure the line to the controller is active.

Macintosh users no longer have to go in the back door to gain entrance to the corporate mainframe. DCA's MacIRMA terminal emulator package provides direct access.

PAUL FIRGENS



The MacIRMA software runs as a task in a Mac window (see photo 1). Within that window, it operates like an IBM 3270-type terminal with many of the same features—a status line at the bottom of the window, reverse video, bold characters, and similar colors.

However, the background on an IBM terminal is dark, while the MacIRMA background is white, like the standard Mac background. Some of the colors on the IBM terminal, intended to contrast against a dark background, are difficult to read on the white Mac display. DCA will offer a black-screen background option with the release of version 1.1.

MacIRMA emulates IBM 3278 and 3279 terminals (models 2, 3, 4, and 5) connected to 3174, 3274, or 3276 controllers. The 3278 display is monochrome, and the 3279 display is color. A model 2 display is 24 lines by 80 characters; a model 3 is 32-by-8; a model 4 display is 43-by-80; and a model 5 is 27-by-132.

One disappointment in the MacIRMA product is that it cannot display mainframe graphics, such as IBM's Graphical Data Display Manager (GDDM), or similar applications. This is an unfortunate situation because the Mac is graphically oriented and its users tend to expect applications that make good use of this capability.

TABLE 1: ***MacIRMA and IRMA 2 Comparison***

	MacIRMA 1.0	IRMA 2
3278/79 models emulated	2, 3, 4, 5	2, 3, 4, 5
File/transfer methods		
IRMAlink (mainframe program)	●	●
ForteNet (mainframe program)	●	○
FT78X (editor based)	○	●
IBM's FT/3270 (mainframe program)	●	●
File/transfer environment support		
MVS	●	●
CMS	●	●
Reconfigurable keyboard	●	●
Specialized keyboard support (RPQ, APL)	○	●
Mainframe color graphics (GDDM)	○	○
Copy screen displays		
to controller printer	●	●
to local printer	●	●
to disk	●	●
Diagnostic support	●	●
Light-pen support	○	●
Application program interface (API) support	○	●
Copy-and-paste support	●	○
Alternate I/O address	N/A	●

● = *Yes* ○ = *No*

MacIRMA emulates four 3278/79 terminal models. It offers Mac users many of the same features PC users have with DCA's IRMA 2, plus copy-and-paste support.

INTEGRAL KEYBOARD

Mac users also may be a little frustrated because MacIRMA does not allow them to use the mouse as much as they are accustomed. Version 1.1 of the product will take better advantage of the mouse.

The Mac keyboard is also very different from that of the IBM 3278. In standard emulator style, DCA maps the specialized terminal keys to combinations of keystrokes. (The F1 key on 3270-type terminals is equivalent to holding the Ctrl key while pressing the number 1 key on the Mac, for example.) This arrangement is more awkward than dedicated keys, but anyone who has been able to adapt to the PC IRMA keyboard will have little trouble using the MacIRMA keyboard.

To simplify matters, Apple supplies a utility called Easy Access that allows a user to type keystroke combinations without pressing the keys simultaneously. A *modifier* key (*control*, *shift*, *option*, or the *Apple* key) followed by a standard key produces the same effect as if the keys are pressed simultaneously. This feature is particularly useful with MacIRMA because keystroke combinations (of a modifier and a regular key) are an integral part of the package. It's a nice touch.

Even simpler yet is using a mouse with the Quick Pad menu, as DCA calls it. The user pulls down a menu and clicks the mouse pointer on the square with the name of the desired function.

The Mac user can easily change the default key assignments using another pull-down menu to call up a window that displays a 3278 and a Mac keyboard (see photo 2). To assign an IBM-key value to a Mac key, the user points to an IBM key with the mouse, clicks and holds the mouse button, and rolls the pointer to the desired Mac key. The key changes are effective immediately. The user can change the Quick Pad layout the same way.

MacIRMA does not give as much control over redefining the keyboard as does IRMA 2. With IRMA 2, users can redefine the PC keyboard two ways. The easiest method is to create keystroke macros. The user also can remap the keyboard by replacing the interrupt 9H BIOS keyboard processor with a customized handler provided with the package. The first method is simple and has the advantage of being dynamic. The second method, while more complicated, gives the most flexibility and control.

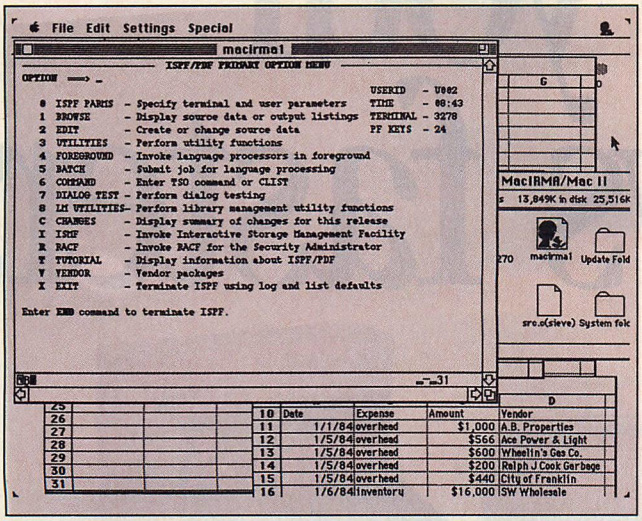
Both IRMA 2 methods work outside of that program, whereas the MacIRMA procedure does not work outside of the MacIRMA application window. The MacIRMA procedure, however, is easier to use because the basic operations are much more intuitive: the user merely looks at a map of the keyboard, picks up new key values, and replaces the original keys.

The PC version documents the IRMA card's screen buffer and I/O port and even includes sample access programs that allow the user to access the mainframe. Unfortunately, that information is not included in the MacIRMA package. DCA does not plan to supply this information for MacIRMA but intends to release an application programming interface during the third quarter of 1988, which may provide MacIRMA much of the same flexible access now available with IRMA.

TALKING TO BIG BROTHER

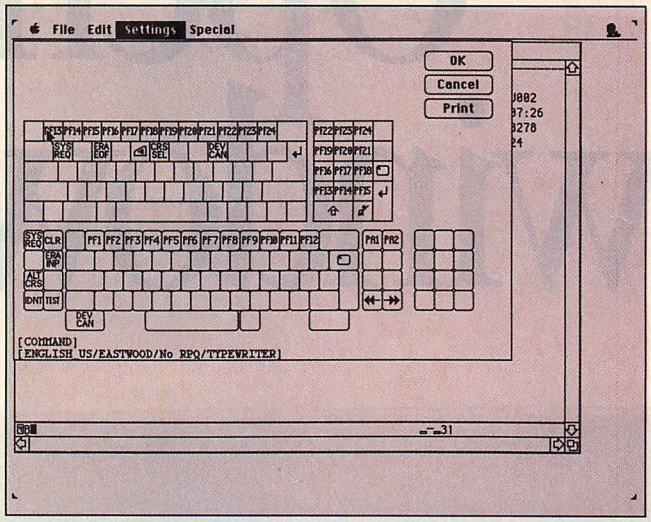
For this review, MacIRMA 1.0 was installed in a Macintosh II with 5MB of memory, a color monitor, and a standard 85-key Macintosh keyboard. (Another version of the MacIRMA program is available for the Macintosh SE.) The Mac II was connected to an IBM 3090 series mainframe directly through a 3274 controller.

PHOTO 1: *Mainframe Window*



MacIRMA runs as a task in a window on the Mac. The familiar 3270-type terminal display appears in the window, complete with the status line at the bottom. Features supported include reverse video, bold characters, and color.

PHOTO 2: *Macintosh Key Assignment*



To assign a particular IBM 3270 terminal key value to a Mac key, a user points to the appropriate IBM key with the mouse, clicks and holds the mouse button, rolls the pointer to the Mac key, and releases the mouse button.

Used continuously for one month with a variety of mainframe software, MacIRMA had no problems with the standard terminal communications functions. It also got along well with other Mac software, such as Apple's MultiFinder, and when using copy-and-paste operations.

MultiFinder, a limited form of multitasking, does not provide a complete memory-protected environment but does let applications share some of the machine resources. Not all Mac applications cooperate with MultiFinder, but MacIRMA does. A user can copy information between applications without quitting and saving the first application before starting the second.

Mainframe applications also can run in a MacIRMA window while other Mac applications run in other windows. For example, a user can run a lengthy spreadsheet recalculation while working on the mainframe. When MultiFinder runs with other Mac applications, no problems originate with MacIRMA, although the emulator does not allow background data transfers.

Mac applications generally let users copy portions of their windows and paste them into other applications. MacIRMA is no exception. Pieces of mainframe displays can be copied directly into Mac applications; data also can be pasted from a Mac application onto the mainframe window.

Copying from a mainframe window to a Mac application works with no problems, as does pasting to a mainframe window when the operation covers the entire width of the window. Problems are encountered, however, when pasting pieces of data narrower than the width of the window, such as a table onto a text file. The new text is displayed in the window in the place marked for it, but when it is saved, only the first line pasted in the window can be retrieved. DCA plans to fix the problem in a future release.

MacIRMA supports three protocols for moving data between the Mac and the mainframe: IRMAlink and ForteNet (both DCA products), and FT/3270 from IBM. All three require special software on the mainframe to assist in the file-transfer process. The mainframe editor-compatible transfer programs included with PC IRMA are not available with MacIRMA. Editor-compatible transfer programs require no special software on the mainframe; however, transfers are not as fast or reliable as with host-assisted programs.

DCA supplies its IRMAlink software to each mainframe site at no extra cost. File transfers tested with the IBM package FT/3270 through time-share option (TSO) worked without a hitch. According to DCA, MacIRMA works with versions of FT/3270 available for CICS and VM/CMS. Files transferred can be binary or text. The original source can be a mainframe, PC, or another Mac.

The user invokes the transfer operation from within the MacIRMA window by selecting the FILE pull-down menu and choosing the appropriate SEND or RECEIVE option. The user can choose source and destination options as well as transfer protocols and related options. Photo 3 shows the menu for FT/3270 protocol and available options, such as ASCII/EBCDIC character translations and carriage-return/line-feed insertions and deletions.

Another MacIRMA file-transfer option, unique to the Macintosh, is the Resource Format choice, which is shown in the lower left of the screen in photo 3. This option moves a Mac file with its *resources*, which describe what kind of data the file contains (text, a photo, an application program, and so on), and the icons and fonts associated with the file. Resources must be included if the user wants to reconstruct the original Mac application after a transfer. They are not needed to transfer some types of files—word processing documents, for example.

Choosing the Configure option displays another menu (photo 4) where the user can include specific parameters about the mainframe data set, the length of time MacIRMA waits for activity from the mainframe before it quits the transfer procedure, and the command sent to the mainframe to start the file transfer.

MacIRMA transfers files in a reasonable amount of time; a 406KB spreadsheet was downloaded to the Mac in 3 minutes 15 seconds with the MVS/TSO version of IBM's FT/3270 through a locally attached controller.

An acceptable speed in transferring files is not enough, however, for successful data sharing. The target application must be capable of processing the

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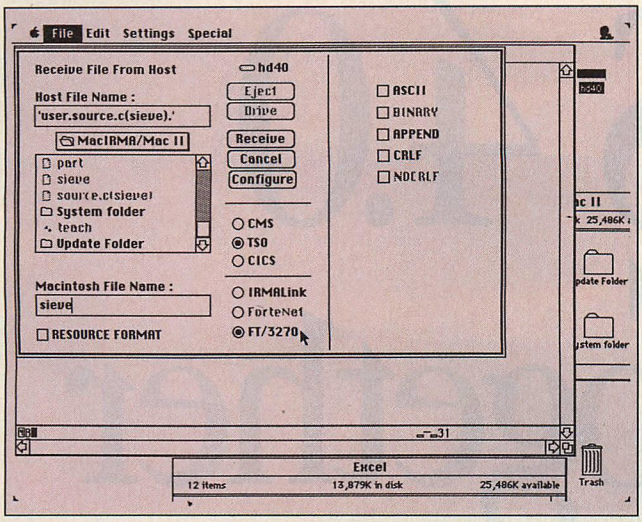
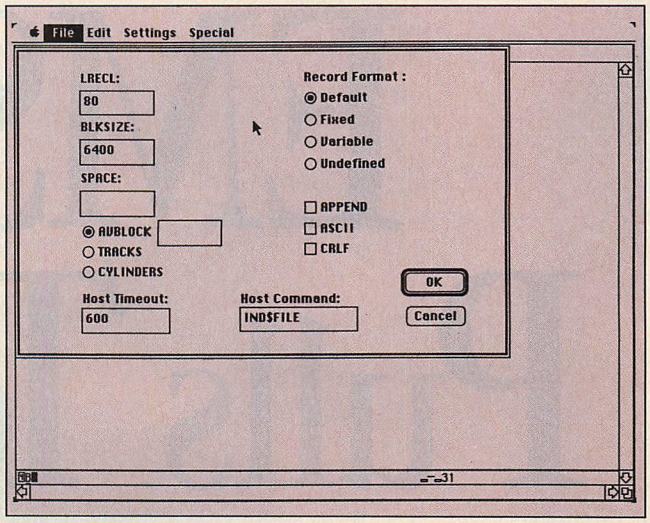
CIRCLE NO. 235 ON READER SERVICE CARD

PHOTO 3: *File-transfer Protocol*



MacIRMA supports IRMAlink, ForteNet, and FT/3270 file-transfer protocols. The protocol and options require special file-transfer software on the mainframe; DCA supplies the IRMAlink mainframe software to each site at no extra cost.

PHOTO 4: *File-transfer Parameters*



The file-transfer configuration menu specifies parameters about the mainframe data set, the length of time MacIRMA will wait for activity from the mainframe, and the command sent to the mainframe that is used to start the file transfer.

data in those files; generally, the transferred data must be converted to formats usable by the new application.

File-transfer software begins this process by converting mainframe EBCDIC text to ASCII text for the microcomputer. However, binary files (such as spreadsheets and word processing documents containing control codes) present a different situation because the file-transfer software does not do any conversion and only transfers these files to the target machine. If the files are not executable programs, other handlers must convert them to a usable form.

To solve this problem, Apple supplies a utility for converting files from one format to another—WordStar to MacWrite or IBM document content architecture to MacWrite, for example. Apple expects third-party developers to supply other conversion routines.

Fortunately, some applications can use foreign format files without a conversion utility. Microsoft's Excel running on a Mac can read Lotus 1-2-3 files directly, including most of the 1-2-3 macro formulas, and can reproduce the original spreadsheet. Such a setup makes data sharing between Mac and PC users even more efficient.

MACIRMA 1.1 ENHANCEMENTS

Version 1.0 of MacIRMA was tested for the article. As the review was being completed, DCA announced the release of version 1.1, which includes several worthwhile enhancements. (DCA is offering the upgrade from 1.0 at no charge if it is made within the 90-day warranty period; otherwise, the cost is $75.) The following comments are based on a trial of a beta version.

An optional black-screen background is included with this release. It makes the screen easier to read, particularly when color is used, and might make regular 3270 terminal users feel more comfortable with the Mac display.

With the new release, the mouse does more of the work. It can position the cursor; when the mouse button is clicked, the cursor moves to the selected position on the screen (the position is indicated by the I-beam cursor). This saves a user from having to tab multiple times through a screen full of options. The user can move the I-beam to the required position and click to move the cursor there. The mouse also can be set to default to simulate a light pen; the usual I-beam displays as a light pen in the MacIRMA window.

IBM Dual Session mode (RPQ) and international keyboard layouts are now supported. If the controller is properly configured, this added support enables the emulator to provide two sessions. The MacIRMA session sounds a tone when the Poll/Alarm command is sent from the controller. The monkey screech (a standard Mac sound option) beeps when you make an error on the terminal.

THE BIG PICTURE

MacIRMA works well. It is a viable and useful product and continues the same high-quality tradition set by the original IRMA products. With MacIRMA, Mac users now can have access to the same mainframe data and applications that PC users have enjoyed for many years, and the Mac can take another step toward acceptance in the corporate world.

Moreover, widespread acceptance of Macintosh-type graphics interfaces can play an even larger role in the future of microcomputing. A Mac running MacIRMA is a history lesson in user interfaces. IBM's plans for the future of application design centers around Systems Application Architecture (SAA), with OS/2 Extended Edition 1.1 as the PC implementation of these plans. The OS/2 Presentation Manager is similar to the Macintosh's user interface. (For additional information, see "The User at the Controls," Ed McNierney, March 1988, p. 64; and "SAA: IBM's Road Map to the Future," Dennis Linnell, April 1988, p. 86.) If the Presentation Manager is successful, the Macintosh environment represents the future of application design, and the mainframe terminal screen displayed in the MacIRMA window represents the past.

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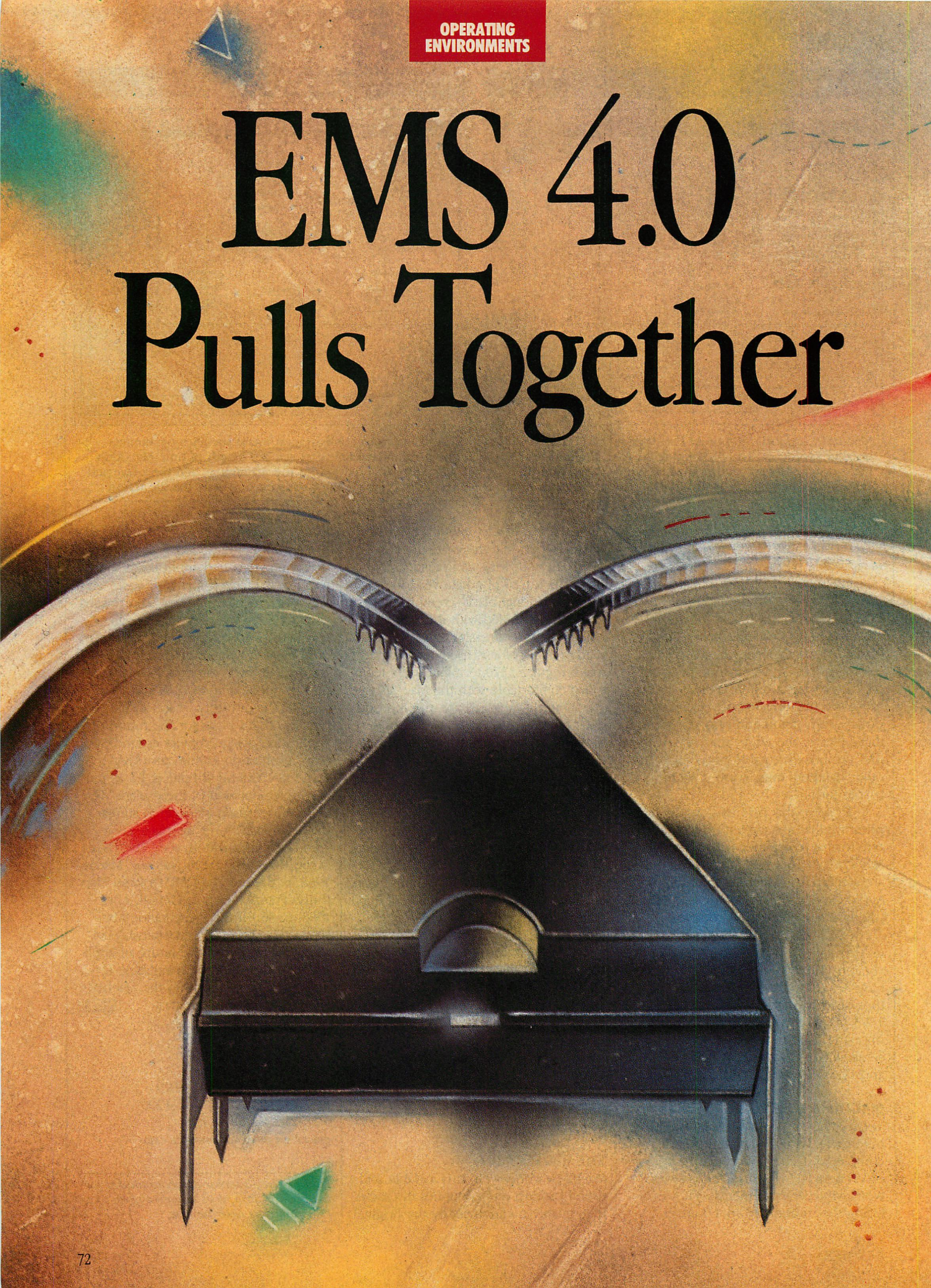
Alpharetta, GA 30201-4199
800/241-4762; 404/442-4000
MacIRMA 1.0: $1,195

CIRCLE 329 ON READER SERVICE CARD

Paul Firgens, a senior database analyst for a Wisconsin firm, does extensive work in a PC-mainframe environment.

EMS 4.0 Pulls Together



In search of supernumerary memory for DOS applications, EMS 4.0 unites something old, something borrowed, and something new.

TED MIRECKI

Until applications arrive that fulfill the promise of OS/2, many users are searching for alternatives that can run widely available DOS applications, yet overcome the limitations of that operating system. Expanded memory is the technology that gives such alternatives a large part of their power. The Lotus/Intel/Microsoft Expanded Memory Specification (EMS) version 4.0 unites features of earlier EMS versions with strengths of the AST Research/Quadram/Ashton-Tate Enhanced Expanded Memory Specification (EEMS), and it adds some traits of its own to create a new and improved EMS. The new version may open all kinds of doors for DOS applications.

Lotus, Intel, and Microsoft originally developed EMS to relieve the spreadsheet power user's memory crunch. It was intended to provide 8MB of memory beyond the 640KB limit as a repository for data such as spreadsheet cells or a RAM disk. Because most programs of this type already provided their own data space management, expanded-memory management was also left at the application level. Therefore, expanded memory benefited applications only to the extent that they were written specifically to take advantage of it. Such applications and utilities soon proliferated.

However, DOS systems needed additional memory for purposes other than data storage. Programs were growing in size, and users were discovering multitasking in the form of terminate-and-stay-resident (TSR) utilities and task-switching environments that loaded more than one program at a time. Although the original EMS offered the possibility of expanding the memory space by an order of magnitude, the design of its hardware interface with the rest of the system made it inefficient for running multiple programs.

To provide for this further use of expanded memory, AST, Quadram, and Ashton-Tate developed EEMS. For applications and small TSR utilities, EEMS provides the same capabilities, in the same way, as EMS. For system-level control programs that create and manage task-switching or multitasking environments, it efficiently expands memory available for running programs.

The most notable EEMS success is DESQview from Quarterdeck Office Systems. DESQview and Microsoft Windows run on top of DOS and rely on a hardware solution to expanded memory. Either of these, in conjunction with underlying hardware, can provide two features lacking in DOS: a large address space and multitasking. They are among alternatives to OS/2 reviewed in the January issue (see "Choosing An Operating System," and "386 Operating Environments," Ed McNierney, p. 50 and p. 60, respectively, and "The DOS-UNIX Union," William Tropp and Stephen Wright, p. 78).

Quarterdeck's windowing multitasking environment is much like Microsoft Windows, but it is text-based and menu-driven instead of graphics- and icon-oriented. It can simultaneously run—not just hold in memory for task switching but actually execute—as many programs as will fit in available expanded memory. By comparison, Windows versions prior to 2.0 used EMS memory for data storage only, so it could multitask only as many programs as fit in the 640KB of conventional memory space at one time.

DESQview demonstrated that expanded memory could go beyond merely providing data storage space. In recognition of this fact, Lotus, Intel, and Microsoft revised their specification extensively to create EMS 4.0. The major changes are increasing the maximum expanded memory space from 8MB to 32MB, incorporating the same hardware interface as EEMS, and adding multitasking support in software.

Part of the motivation for this revision was undoubtedly the release of Windows 2.0, which takes advantage of the multitasking support provided by EMS 4.0 software running on appropriate hardware. Another reason could have been the design of IBM's 80286 Memory Expansion board for the PS/2 Models 50 and 60, which supports a mapping scheme functionally equivalent to EEMS (but for reasons other than providing expanded memory).

SOMETHING OLD

Understanding expanded memory requires clear definitions of the terms used in describing the memory architecture of a PC system. The *system ad-*

ILLUSTRATION • GARY HENRIE

dress space is memory addressable by the CPU. In real mode (the only mode available to 8088 processors), the address space is 1MB. In protected mode, it is 16MB for 80286-based computers and 4GB for 80386-based machines. *Conventional memory* is the portion of system address space available to DOS. On most PC-compatible systems, this is limited to 640KB, but this number is a consequence of hardware design, not an inherent limitation of DOS.

Extended memory is memory above 1MB that lies within the system address space of a 286 or 386. It is accessible only after switching into protected mode (for example, under OS/2 or UNIX), whereupon it becomes part of the larger system address space. DOS cannot use this memory, but the BIOS of 286- and 386-based systems has procedures for transferring data between conventional and extended memory by temporarily switching into protected mode. This facility is of use to device drivers (such as VDISK) that implement a RAM disk in extended memory. EMS is not concerned in any way with extended memory.

Expanded memory resides outside system address space and therefore cannot be accessed directly in any processor mode. It is applicable in real mode only to provide memory in excess of the conventional memory limit. Expanded memory is divided into *pages* of 16KB and accessed by mapping some number of these pages into unused portions of this address space. Each 16KB block of the system address space that can hold an expanded memory page is called a *page frame*.

The implementation of expanded memory requires both hardware and software components. The hardware must allow changing of the effective address of memory under software control. This capability is built into the 386 processor, but for 286- and 8088-based systems, it must be provided by hardware on the memory board. On such boards, each page frame requires a page register whose contents determine which expanded-memory page appears at the address of that frame.

Software needed to control mapping takes the form of a device driver called the Expanded Memory Manager (EMM). However, programs that use expanded memory communicate with the EMM not through DOS calls or IOCTL functions (the normal means for applications to talk to device drivers) but through interrupt 67H. Typically, interrupt handlers are installed as TSR programs, not device drivers.

TABLE 1: *EMM Functions Common to All Versions*

FUNCTION	DESCRIPTION
1	Get EMM status.
2	Get page-frame base address.
3	Get total number of pages and free-page count.
4	Assign an EMS handle ID and allocate pages to it.
5	Map a single page into a page frame.
6	Close an EMS handle and deallocate all its pages.
7	Get the EMM version number.
8	Save the EMM status in an internal buffer.
9	Restore the EMM status from the internal buffer.
10–11	Reserved.
12	Get the number of active EMS handles.
13	Get the number of pages allocated to a specific handle.
14	Get an array of page counts per handle.
15	Save, restore, or swap the EMM status to/from an external buffer.

The basic set of EMM functions defined by EMS 3.2 is a proper subset of the functions supported by both EEMS 3.2 and EMS 4.0. Programs using only this set of functions are compatible with all EMS hardware and software.

The EMS and EEMS implementation of the EMM as a device driver turns out to be an unfortunate choice because it makes expanded memory unusable in the DOS compatibility mode of OS/2. If the EMM were a TSR, it could be installed after switching to the OS/2 real mode, and DOS applications running in the compatibility box could fully use expanded memory. But a DOS device driver, even if it is designed for real mode only, cannot be installed under OS/2. Using EMS memory in the DOS box will be possible when and if EMM drivers are rewritten to allow installation under OS/2.

Table 1 lists the basic set of functions common to all implementations of EMS. The use of these functions was described in detail in two previous articles: "Expandable Memory," Ted Mirecki, February 1986, p. 66, and "Reaching into Expanded Memory," John A. Lefor and Karen Lund, May 1987, p. 100.

SOMETHING BORROWED

The differences introduced by EEMS (and now adopted by EMS 4.0) have to do with the number and location of page frames in the system address space. Incorporation of these features into EMS acknowledges the role that expanded memory can play in support of multitasking operating environments.

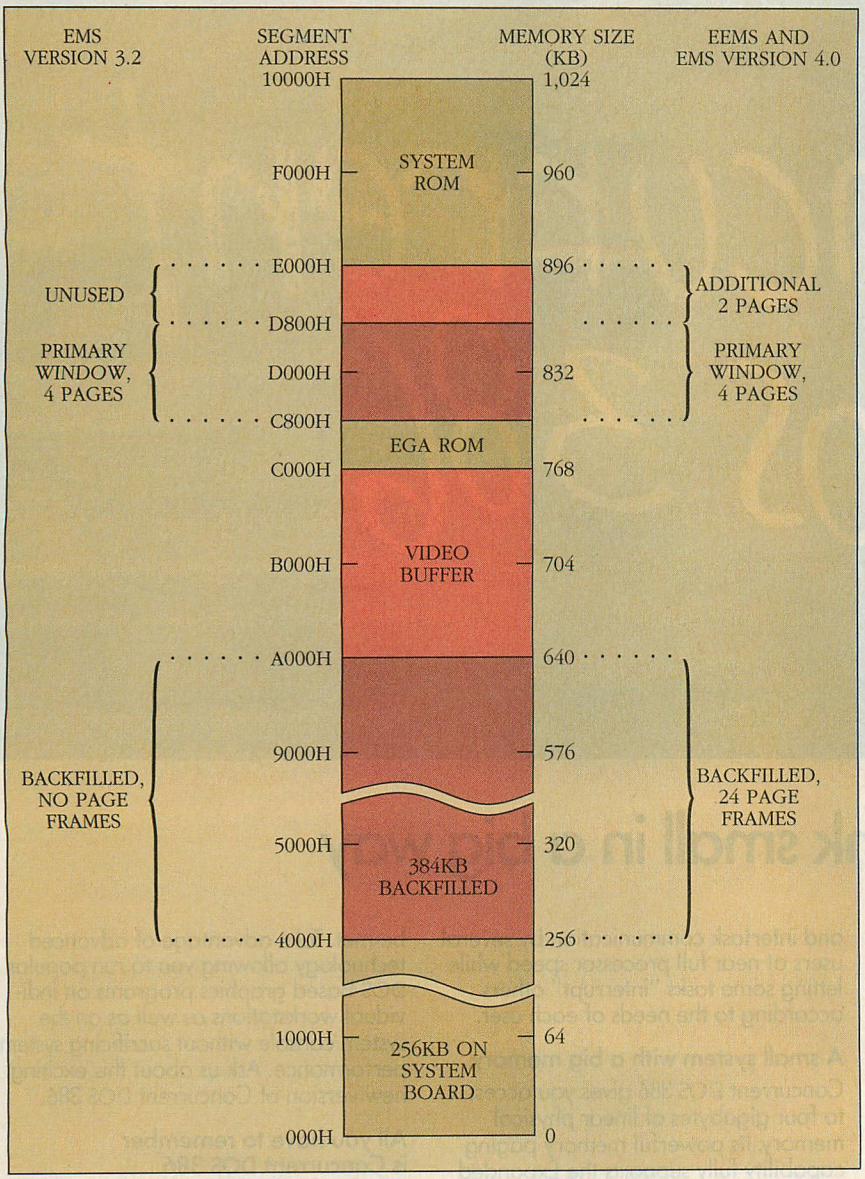
EMS 3.2 specifies four contiguous page frames above conventional memory, creating a 64KB window into expanded memory. EEMS allows a page frame in every unused 16KB block in the system address space, both above and within conventional memory.

In version 3.2 of each specification, EEMS is a proper superset of EMS, meaning that EEMS performs the same functions in the same way—and adds more. All software written to take advantage of EMS runs flawlessly on EEMS hardware. Little practical difference exists at the applications level, and no widely marketed applications take advantage of features specific to EEMS. These features are meant to be used by systems-level software such as multitasking operating environments.

To illustrate the advantages of mapping expanded memory into the conventional address space, consider a system with 256KB of memory on the system board, an EGA, and a 2MB expanded memory board with 2MB of memory (see figure 1). The memory board is configured to backfill conventional memory to 640KB. If this board conforms to EMS 3.2, it provides a window of four page frames. By default, these are located at segments C800H, CC00H, D000H, and D400H; the user also can configure the window to begin at CC00H or D000H. In any case, two of the six available 16KB blocks remain unused. The 384KB used to backfill conventional memory are lost from the expanded memory pool, leaving 1,664KB (104 pages) of expanded memory available to the EMM.

If the memory expansion board is constructed to the standards of EEMS 3.2 or EMS 4.0, the primary window at segment C800H can extend over six page frames instead of four, allowing an application to manipulate 96KB of expanded memory at a time instead of 64KB. In addition, the backfilled mem-

FIGURE 1: ***Example Memory Configuration***



Previous versions of EMS were limited to providing four page frames above conventional memory. Version 4.0, like previous versions of EEMS, allows a page frame in any 16KB block, above or below 640KB, not populated by RAM or ROM.

ory below 640KB supports page frames, allowing the mapping of expanded memory pages into conventional memory. Memory used for backfilling remains in the expanded memory pool. While the primary window is meant to be controlled by applications, only an operating system or system-level tasking environment should manage page frames within conventional memory.

If an operating environment running several co-resident applications consumes the entire conventional memory space, and the user requests start-up of yet another application, a program must be unloaded from memory to make room for the new one. In the absence of expanded memory, one of the applications must be written out to disk before a new one is loaded. With EMS memory, the operating environment could copy an application into expanded memory with this sequence:

1. Allocate a sufficient number of expanded memory pages to hold the unloaded application.
2. Map four of those pages into the window at segment C800H.
3. Copy 64KB from conventional memory to the window.
4. Loop back to step 2 until the system has copied sufficient memory to hold the new application.

With EEMS's paged memory below 640KB, an application in the upper 384KB of conventional memory already resides in expanded memory, so it does not need to be copied out to make room for a new program. Instead, the operating system merely allocates pages for the new application and maps them into page frames in conventional memory. Pages formerly in these frames become inaccessible but retain their contents. This process requires the same number of calls to the EMM (one for each page of the new application) but avoids copying each byte of data through the primary window.

The advantage of EEMS and EMS 4.0 over EMS 3.2 is even greater when the system needs to switch between two previously loaded applications—one in conventional memory, the other in expanded. With previous EMS versions, the system must perform two copies: one to roll out the application being suspended, another to roll in the application being activated. With EEMS and EMS 4.0, it performs both functions merely by mapping the pages holding the incoming application. The pages holding the suspended application are mapped out but not overwritten.

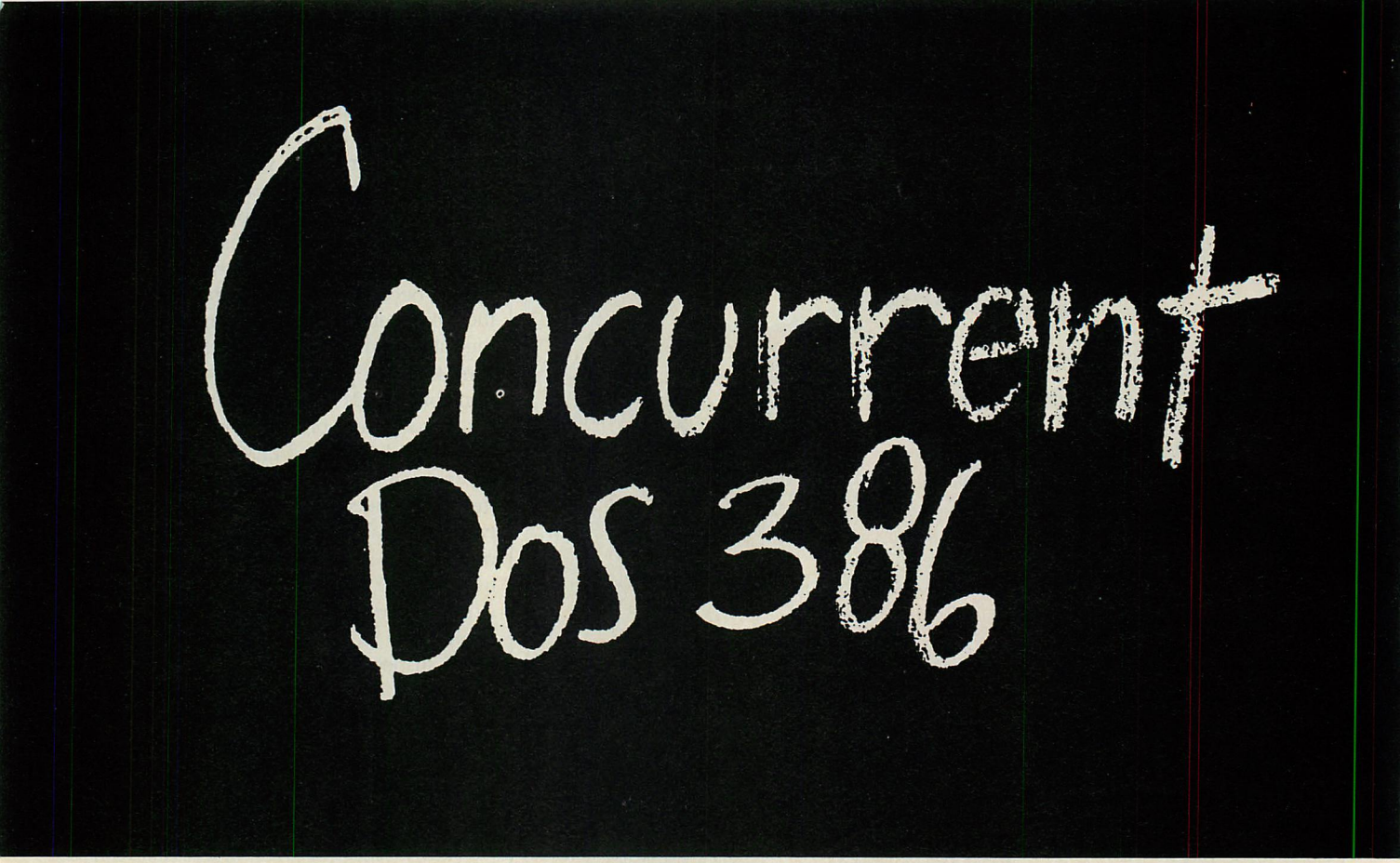
An EEMS or EMS 4.0 board can contain two sets of page registers, with each set containing mapping information for a distinct set of expanded memory pages. By specifying one or the other as the active register set, an entire set of pages can be mapped in with one call to the EMM.

Another advantage of EEMS and EMS 4.0 is that they provide more memory for simultaneously holding applications. With EMS 3.2, the example configuration provides 104 pages of expanded memory for holding inactive applications; active applications are replicated in the conventional memory space. With EEMS and EMS 4.0, 128 pages are available because an active application does not appear twice.

SOMETHING NEW

Besides incorporating EEMS features, EMS 4.0 adds others that provide even more support for multitasking. These features are described below in functional groups; EMM functions that implement them are listed in table 2.

Named handles. The set of expanded memory pages a program obtains by one call to the EMM is identified by a number called the *EMM handle*. To map a page into the system address space, the program identifies it by specifying the handle number and a logical page number ranging from zero to one less than the number of pages allocated to that handle. Function 20 allows the assignment of an eight-



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character name of the user's choice to any handle. The EMM keeps a directory of handle names, and function 21 searches this directory and returns the handle number for a given name. This feature can be used for communication between cooperating programs.

For example, a database program could allocate some pages and store data in them. If the program gives a name to the handle, another program that knows the name (say a word processor or spreadsheet) can find out from the EMM the handle number associated with the name. Knowing the handle, the second program can access the data stored in these pages. The handle number cannot be hard-coded into programs because this number can change at every execution, depending on the order in which various co-resident programs are loaded.

Physical page addressing. In previous EMS versions, page frames in the system address space are identified by frame number. For the configuration shown in figure 1, the four frames in the primary window are numbered from 0 for the frame at segment C800H, to 3 for the one at D400H. In the EEMS implementation, the first four frames are numbered the same way; frames at D800H and DC00H are designated as 4 and 5, respectively, and the ones beginning at 4000H in conventional memory are numbered from 6 upward. When mapping an expanded memory page, a program specifies its location in the system address space by supplying the frame number.

For compatibility, version 4.0 accepts the same frame numbering, but function 17 also allows specifying the location of the frame by its physical segment address. When calling this function to map a page into the lowest frame in conventional memory, a program could pass either 4000H or 6 as the frame argument. A subfunction code specifies the argument type.

Function 25 constructs an array of all page-frame addresses in the system; it is similar, but not identical, to EEMS function 41. Entries in the array returned by function 25 are ordered by physical address and consist of two words: the segment address and the frame number. Function 41 returns an array of bytes containing the high-order six bits of each frame's address; entries are ordered by frame number, with the address for frame *N* in the *Nth* byte of the array. The new method is more convenient for physical addressing of page frames, the old one for addressing them by number.

TABLE 2: ***EMM Functions Added in EMS 4.0***

FUNCTION	DESCRIPTION
16	Save/Restore partial page map.
17	Map/Unmap multiple pages into page frames.
18	Change number of pages allocated to a handle.
19	Get/Set volatility attribute of a handle.
20	Get/Set handle name.
21	Get handle number for handle name.
22	Alter page map and jump to a far address.
23	Alter page map, call a far address, then restore page map.
24	Move/Exchange contents of memory block.
25	Get array of page-frame addresses.
26	Get expanded memory hardware information.
27	Allocate pages in sizes other than 16KB blocks.
28	Control alternate mapping registers.
29	Prepare expanded memory hardware for warm reboot.
30	Disable/Enable system-level EMM functions.

The new EMS 4.0 functions that support the hardware features defined earlier by EEMS are inoperative on existing EMS boards. All EMS boards, however, can benefit from the functions that add software support for multitasking control programs.

Raw page sizes. The division of expanded memory into pages of 16KB is not convenient when the hardware implements a paging scheme with a different page size. For example, the 386 processor performs paging in increments of 4KB. In version 4.0, an EMM can be written to allocate expanded memory in units that are convenient to the hardware, provided that the size of such a unit, called a *raw page*, is a submultiple of 16KB. Function 27 creates a raw handle and allocates to it a specified number of raw pages. All subsequent page operations for this handle, such as mapping pages or changing the allocation, must be specified in raw pages.

Multiple register sets. EEMS memory boards are constructed with two sets of page-mapping registers, so that a multitasking operating environment can switch rapidly between mapping contexts for two applications. Version 4.0 extends this to allow memory boards to provide any number of register sets. For boards with a single set of registers, function 28 simulates multiple sets by storing inactive mapping contexts in memory provided by the calling program. The effect of the simulation is the same as if the caller saved and restored contexts with function 15, but the advantage is that the context-switching method appropriate to the capabilities of the hardware resides in the EMM; the calling program need not incorporate logic for both switching register sets and saving contexts.

An even more significant extension is the capability to dedicate specific register sets for use by the direct memory access (DMA) controller for high-speed transfers to and from expanded memory. A program can allocate a set of mapping registers for use by DMA, initiate a DMA request to or from the memory mapped by that set, and then switch the context by means of function 15 or 28. The DMA process continues to use the memory mapped by the DMA set of registers, while the CPU can access a different set of pages mapped by a different register set.

Version 4.0 does not require that EMS boards provide hardware for multiple register sets for either CPU or DMA access; it merely specifies that the EMM can take advantage of this capability if available. In contrast, an EEMS memory board must have exactly two sets of mapping registers for the CPU to use; a version 4.0 EMM also can use these registers. No boards currently on the market support any DMA registers or more than two sets of CPU registers.

Function 26 provides information about the EMS hardware: the raw page size, the number of alternative register sets (after the first), and the number of DMA register sets.

Manipulating register sets should be done only by the operating system or task-switching executive. The system program can use function 30 to disable or enable functions 26 (get EMS hardware information), 28 (manipulate alternate register sets), and 30. Once disabled, these functions return error codes to all callers, even the system.

When function 30 is disabled, how does the system reenable it? Immedi-

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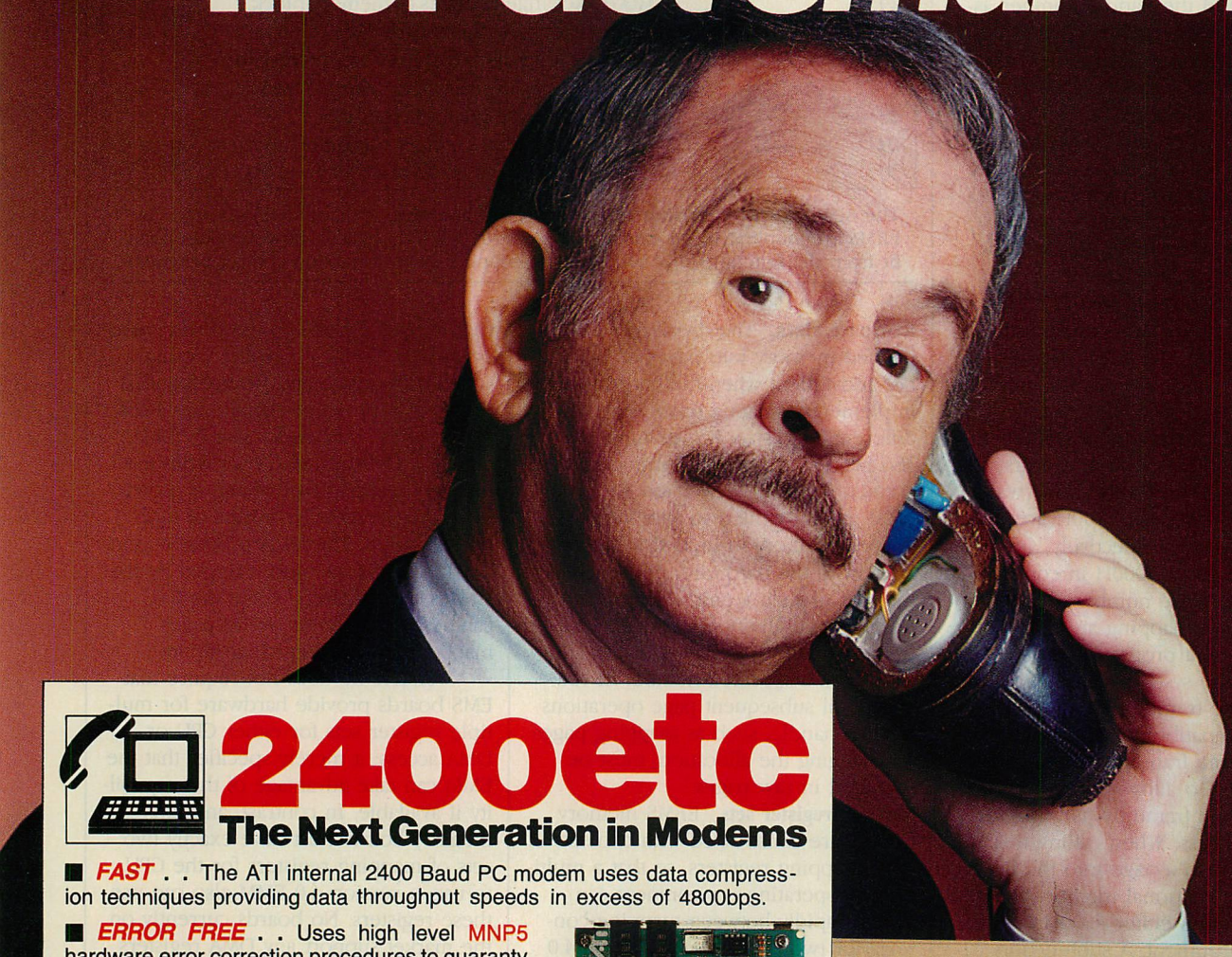

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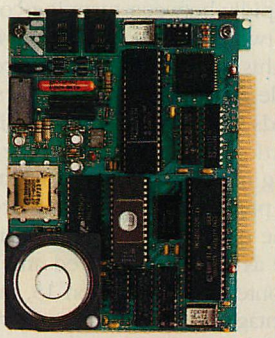

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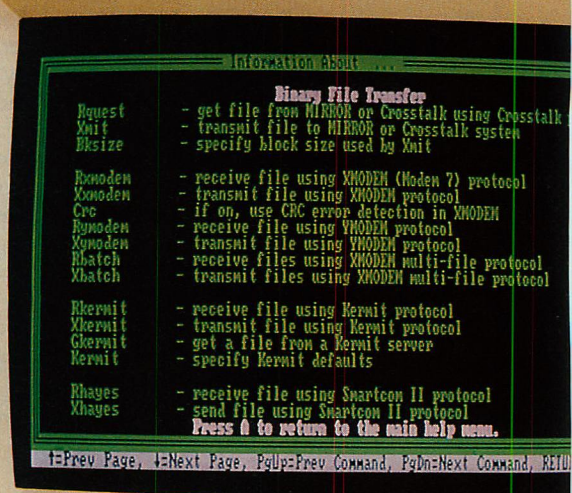

ately after installation of the EMM, the system-level functions are enabled by default. The first call to function 30 returns a random 32-bit access key that must be used on all subsequent calls to the function. Thereafter, function 30 can be called, even when disabled, if the key value is given as a parameter in the call. During its installation, the operating environment is presumably the first program to call function 30, so it is the only one to obtain the key.

Control and data transfers. In a multitasking environment, transfers of control to various programs often involve changes in the mapping context. For example, when a task-switching executive activates a dormant program, it must map that program's expanded memory into the system address space before branching to the program's code. This capability is also useful within an application—for example, when a small TSR kernel in conventional memory maps in and branches to its main code in expanded memory.

Function 22 automates establishing a new mapping context and jumping to a far address. Logically, it is equivalent to a call to function 27 (map multiple pages), followed by a far jump to an absolute address. The target can be in expanded or conventional memory. As is the case for function 27, the page frames in the new mapping context can be specified either as frame numbers or absolute segment addresses.

Function 23 performs the equivalent of a far call. It saves the current mapping context in a caller-supplied memory area, establishes a new context (in the same way as function 27), and transfers control to a far address. When a far return is subsequently executed, the EMM restores the saved context before returning control to the instruction following the call to function 23.

Function 24 provides a means of efficiently moving or exchanging large blocks of data between expanded and conventional memory or between two areas of expanded memory. In the latter case, the two blocks might belong to different handles. Blocks need not be aligned on page or segment boundaries. Overlapping source and destination blocks are handled properly for a move but generate an error for an exchange. This function is useful for moving data between blocks that span several pages, especially when the blocks are larger than any available contiguous window. The calling program need not save and restore the context before calling this function, nor provide a save area for the EMM to use.

Nonvolatile handles. An EMS board can provide hardware features to maintain the contents of expanded memory through a warm boot created by a keyboard reset or other event that can be trapped by software. Function 19 applies the *nonvolatile* attribute to a handle; only the data in pages belonging to nonvolatile handles survive a reboot.

Function 29 called just prior to reboot saves data on the EMS board; its specific action is not specified in EMS documentation because that depends on hardware implementation. Typically, function 29 writes information into EMS hardware registers that notifies the EMM driver (when it subsequently reinstalls itself) which data are nonvolatile and therefore are not to be erased during initialization.

Calling function 29 requires the detection of an imminent reboot, and this is not possible in all cases. A replacement interrupt 9 handler can detect a keyboard reset, but two other events can cause a reboot. One is to execute a direct jump to the boot code in ROM, the other is to toggle the pro-

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TABLE 3: ***Support for EEMS Functions***

EEMS 3.2 FUNCTION, SUBFUNCTION	CLOSEST EMS 4.0 EQUIVALENT	DESCRIPTION
33	None	Get addresses of page frames outside of conventional memory.
34	None	Generic accelerator card support.
41	25	Get addresses of all page frames in system.
42	5	Map a page into any frame.
43, 0	16, 0	Save partial page map.
43, 1	16, 1	Restore partial page map.
43, 2	None	Save and restore partial page map.
43, 3	16, 2	Get size of save array.
43, 4, 5	28, 1, 2	Switch to another set of map registers.
43, 6	18	Deallocate pages mapped at initialization to frames in conventional memory.

Version 4.0 of EEMS incorporates most of the enhancements introduced by EEMS version 3.2. Although these services are functionally similar in both versions, they require different calling sequences and produce output in a different format.

cessor's reset pin with a hardware reset button (this generates a hardware branch to the boot location). Software cannot detect either event, and the boot code, being in ROM, cannot be hooked by overwriting its entry point. Therefore, a keyboard reset is the only event that can be expected to preserve nonvolatile data.

Efficiency improvements. Functions 16, 17, and 18 do not add major functionality to the EMM, but they provide services in a more efficient or convenient manner than is available by other means. Function 16 (save partial mapping context) is similar to 15 (save, restore, or swap EMM status to/from an external buffer), but it saves or restores only a specified subset of page-mapping registers, thereby consuming less conventional memory by storing only the essential portion of any context-switching information.

Function 17 (besides supporting physical frame addressing) can map more than one page at a time. It accepts an array of page numbers and page frames, so pages to be mapped need not be consecutive, nor page frames contiguous. As a result, a single call to function 17 can replace many calls to function 5.

Function 18 allows changing the number of pages allocated to a given handle. In previous versions, the page count per handle is fixed; if a process needs more pages, it has to obtain another handle. Handles are a limited resource (the absolute upper limit is 256 and the EMM typically defaults to a lower limit at installation), and obtaining and releasing them involves some overhead.

STILL AN INDIVIDUAL

Although version 4.0 brings to EMS the major features of EEMS and adds others, it is not a proper superset of EEMS because it does not support all EEMS features (see table 3). The missing ones do not diminish the utility of EMS 4.0; they merely indicate different design philosophies.

One of the primary design goals of EEMS is to maintain compatibility with EMS. Therefore, most extensions are implemented by new EMM function calls, not extensions to EMS-defined functions. The standard set of EMM function calls, shared with EMS (see table 1), handles page frames only above conventional memory. The difference is that EEMS can handle more than four page frames in this area.

All other enhancements are supported by a set of functions with distinct numbers. EEMS deals with two sets of page frames: one containing only those above conventional memory, the other containing all frames in the address space. Each set has a distinct numbering scheme and separate mapping function.

The advantage of this EEMS approach is greater integrity. The upper page frames are for use by applications, the lower by the operating system. Each program has its own set of functions, and although an application is not prevented from accessing any frame, mapping lower memory requires the conscious effort of a different function call. By contrast, version 4.0 considers all the page frames as one set—it has no EMM service equivalent to function 33, which returns an array of addresses of only those page frames

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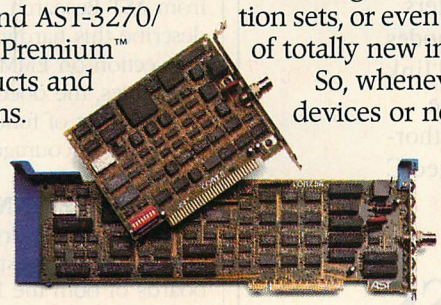

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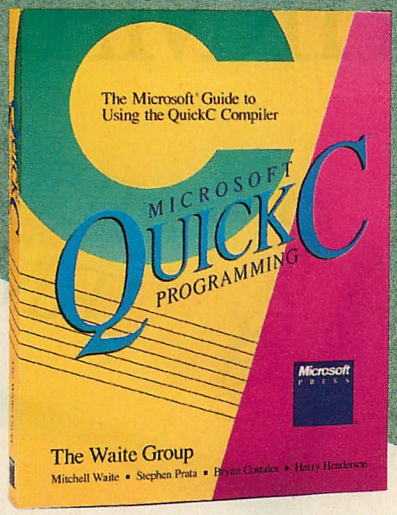

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above conventional memory. Both applications and the system use the same functions (5 and 27) to map upper and lower memory, so an errant program can inadvertently map out a page in conventional memory by supplying a wrong frame number or address.

Although EEMS provides slightly better security than EMS 4.0, all versions of EMS are generally weak in memory protection. This reflects the original purpose of EMS: expanding data storage memory in a single-tasking environment. A program is in no way prevented from accessing expanded memory pages belonging to another program. Access requires only a numeric handle, and any program can obtain a list of active handles. Handle numbers are assigned consecutively from a small range (0 through 255), so a failing program can inadvertently specify a handle belonging to another process. This is especially likely in the case of handle zero, which is owned by the operating system and consists of all pages initially mapped into the back-filled area of conventional memory.

Another feature introduced by EEMS that is not fully incorporated into EMS 4.0 is the interface with caching accelerator boards. Changing the contents of memory by remapping can invalidate the contents of an on-board cache that holds data from the mapped-out location. The caching hardware is unaware of the change because mapping changes the contents of memory by writing to an I/O port, not by direct access to affected locations.

EEMS provides function 34 for communicating with the accelerator board. Support for this function must be provided in both hardware and software by the manufacturer of the accelerator; details are available on request from AST Research. EMS 4.0 does not describe this hardware function, but in the section on EMM implementation guidelines, the documentation states, "the support of function 34, as defined by AST, is encouraged."

JUST THE BEGINNING

Version 4.0 EMM drivers are now available for existing expanded memory boards of both the EMS and EEMS variety. Owners should contact the manufacturers of their boards for information on obtaining updated software.

For this article, four different EMM drivers were tested on five memory boards: Intel's for the Above Board AT, AST's for the RAMpage and RAMpage AT, Quarterdeck's for the IBM 80236 Memory Expansion board for PS/2

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CIRCLE NO. 224 ON READER SERVICE CARD

Models 50 and 60, and Intel's for the Above Board 2 for Models 50 and 60. The boards for the PC and AT were older models originally supplied with version 3.2 drivers. Version 4.0 drivers for the PC and AT ran only with the boards from their manufacturers. The Intel PS/2 driver refused to install itself without an Above Board 2 but could combine memory from the Above Board 2 with memory from an IBM expansion board. The Quarterdeck PS/2 driver worked with either Intel or IBM memory boards or a combination.

All drivers worked well in the tests. The AST and Quarterdeck software supports functions of both the new version 4.0 and older EEMS version 3.2, giving them full functionality with current versions of both DESQview and Windows. Intel's drivers implement only 4.0, so they do not fully support DESQview (which predates version 4.0 and thus issues only EEMS 3.2 calls). The Above Board 2 (but not Above Board models for the PC and AT) provides equivalent context-switching support for Windows 2.03.

Even with an old board, running a new driver provides many innovations, such as named handles, physical addressing, transfer control, and other improvements in efficiency of managing paged memory. These improvements will lie dormant until programs are written to take advantage of them. However, these software features are not 4.0's primary advantages.

Achieving a spectacular improvement in the performance of DESQview or Windows requires hardware support for mapping conventional memory and multiple register sets; these are not implemented on current EMS boards. Version 4.0 does very little for existing EMS boards because they cannot use the most significant new features. For the most part, the effect of installing a new EMM driver on an old board is that the error response to version 4.0 functions is "not implemented" instead of the old driver's "invalid function."

On the other hand, EEMS boards already have the hardware to support the EMS 4.0 mapping protocol. The only two innovations not already supported by EEMS hardware are more than two sets of general mapping registers and mapping registers that are dedicated to DMA transfers. The EEMS 3.2 and EMS 4.0 drivers for EEMS boards provide the same functionality with one immediate exception: with the older driver, Windows 2.0*x* cannot take advantage of the multitasking hardware features of the board.

For those who already own expanded memory boards, EMS 4.0 does little—EMS boards cannot use the major new features, and EEMS boards already have them. Still, the creation of a single unified standard that incorporates and adds to the features of the better one is undoubtedly a step in the right direction. This unification is just in time to provide a consistent memory standard for IBM's PS/2 series—the memory-mapping capability of the Micro Channel memory expansion board no doubt played heavily in the decision to create 4.0.

The capabilities offered by the newly unified EMS to task-switching environments breathes new life into DOS-based applications, providing the opportunity to design characteristics not otherwise available in this operating system: large memory spaces for both programs and data, rapid switching between co-resident programs, and concurrent execution.

Ted Mirecki is a technical editor for PC Tech Journal*, specializing in systems software.*

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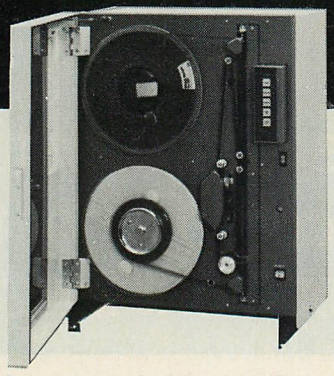

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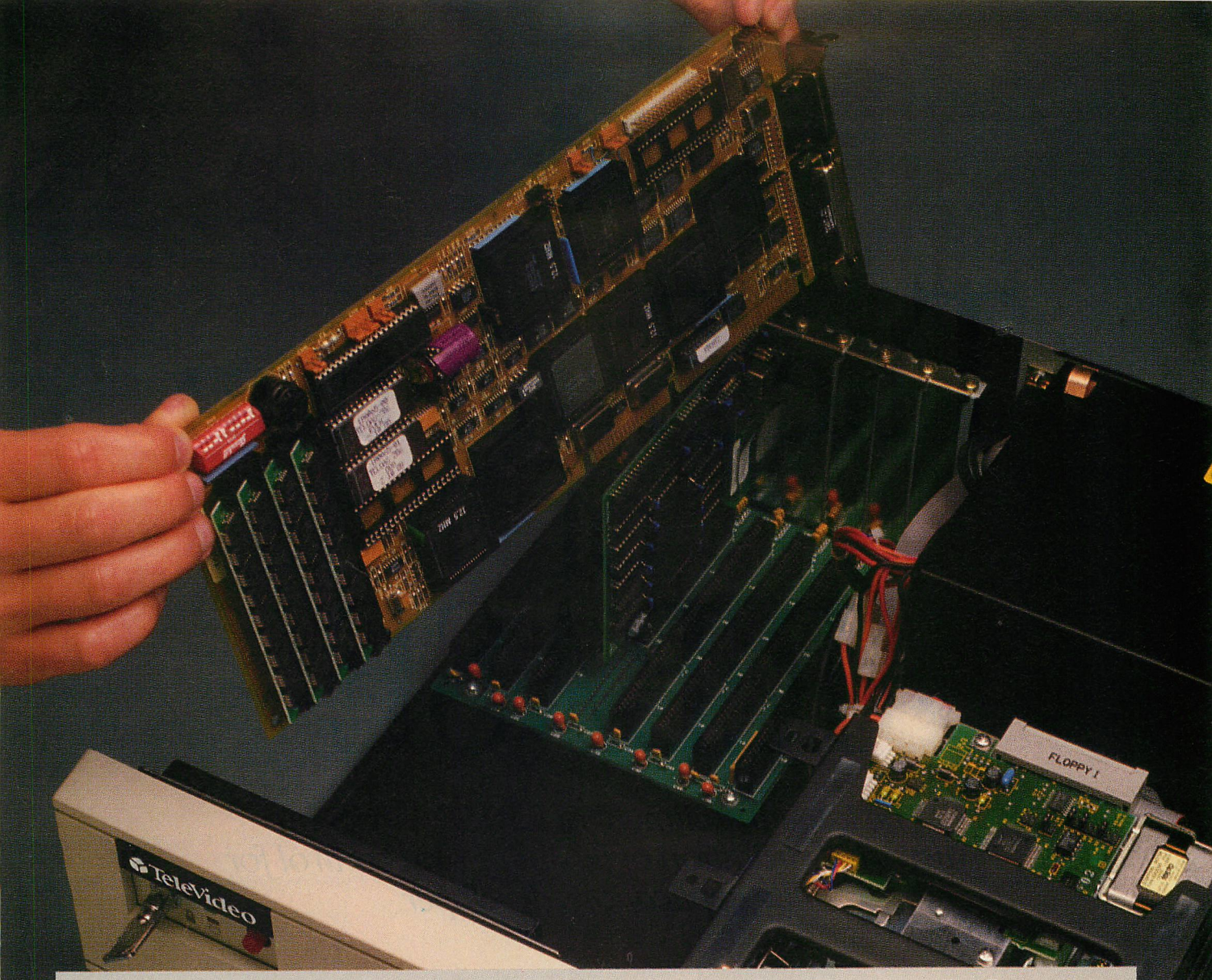

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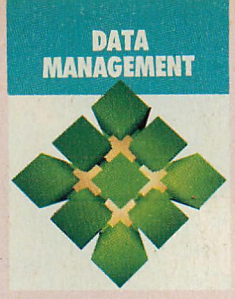


The Evolution of R:BASE

The latest installment of R:BASE carries on Microrim's tradition of flexibility and control for the applications developer.

VICTOR E. WRIGHT

When developing its latest relational data manager, Microrim did not lose sight of what made R:BASE System V popular among programmers—a robust programming language coupled with a flexible generator package that allows developers to design complex applications while writing a minimum amount of source code. R:BASE fans will be happy to learn that none of this has changed.

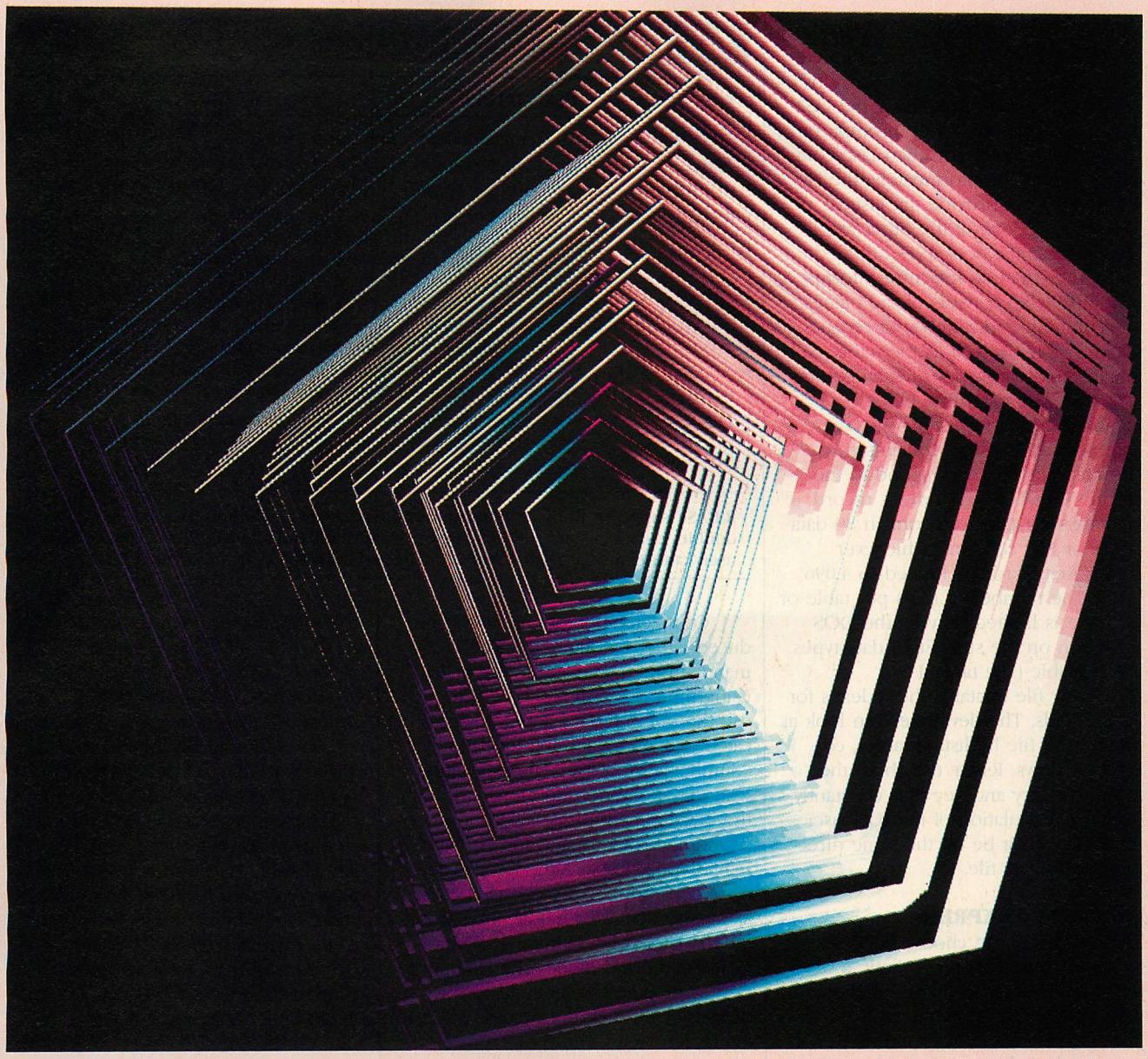
The strengths of System V have been enhanced in R:BASE for DOS with a streamlined prompt-by-example (PBE) user interface, an improved applications generator package, a speedier runtime environment, and some features of the advanced structured query language (SQL) programming language. For an overview to the product, see the sidebar on page 89.

In some cases, these commands provide new capabilities. In others, an existing R:BASE command, such as SELECT, has been extended to include a more SQL-like syntax. For a look at the R:BASE implementation of SQL, see the sidebar, "Integrating SQL Features into R:BASE," on page 98. The new release also is available for OS/2 (see sidebar, "A Closer Look at R:BASE for OS/2," p. 100); a description of Microrim's port of R:BASE from DOS to OS/2 appeared in "Porting to OS/2" (Steven Armbrust, November 1987, p. 140).

R:BASE for DOS is targeted at a wide market, ranging from novice users to professional applications developers. Its programming language is tailor-made for the programmer-developer who wants absolute control for intricate applications, while its modular applications generator should appeal to the more pragmatic developer-user who wants a quick solution and is willing to forego complete control.

R:BASE for DOS is the successor to R:BASE System V, which followed R:BASE 5000 (reviewed in "A Data Manager with Kernel Code Generation," Steven Armbrust and Ted Forgeron, September 1985, p. 82). R:BASE System V represented a major and noticeable overhaul of R:BASE 5000 by providing greater database and file capacities and an enhanced user interface.

For the user, R:BASE for DOS (and for OS/2) represents evolution, not revolution. System V will not be overwhelmed by the new features, even though R:BASE for DOS is a totally new product, completely rewritten in C (previous versions were written in FORTRAN). Microrim says that selected operations—VIEW, SORT, and CROSSTAB—are as much as 20 times faster due to the new implementation in C and the use of heuristic query optimization techniques.



While the new version extends many of the limits of System V and R:BASE 5000, it is compatible with its predecessors as well as with other Microrim R:BASE products, such as DB Graphics, for including presentation graphics (for a review of DB Graphics see Product Watch, this issue, p. 130); CLOUT, for writing natural language queries; Extended Report Writer, for producing complex reports; Program Interface, for interfacing R:BASE with Microsoft C, Pascal, and FORTRAN applications; and Runtime, for publishing applications.

As is the case in the previous versions, the basic application development facility is still the R:BASE command language, a conventional, procedural language with the features developers have come to expect in a data manager, including all the essential characteristics of a general-purpose programming language as well as the R:BASE-specific commands for defining and manipulating the database.

Although the command language is the heart of R:BASE application development, the developer's primary tools are the product's four application generator modules: Definition EXPRESS (for defining or modifying a database), Application EXPRESS (for generating applications), and Forms EXPRESS and Reports EXPRESS (for designing forms and reports, respectively). These menu-driven modules lead the developer or serious user through the process of building an application. They can be selected from the PBE menu or from the R:BASE command prompt.

The system also includes the following utilities: File Gateway (for converting file formats), 3Labels (for creating labels), RBEDIT (for editing text), and CodeLock and Developer's EXPRESS (for increasing the execution speed of applications). The R:BASE system, including the command language, the EXPRESS modules, and the utilities, forms a complete development environment.

DEALING WITH DATA

Like many data managers, R:BASE for DOS uses the relational model, which stores data in tables. Rows in one table can be linked to the rows in another by common columns, without using pointers. Regardless of the number of tables, columns, and keys, R:BASE stores each database in three files: data dictionary, data table, and key. The file names consist of seven user-assigned characters, an R:BASE-assigned number (1, 2, or 3), and the extension .RBF.

A data-dictionary file contains the database schema (structure definition) and disk and directory of the data tables; this file is created automatically

COMPUTER GRAPHIC • DOV JACOBSON

by R:BASE as the developer defines the database. The developer can examine the contents of the data dictionary by querying the dictionary using the LIST command from the R:BASE prompt, or by selecting Query and then List from the PBE menu. (Unfortunately, the List menu does not provide the List All command, so one of the other List commands must be selected and edited.) The database structure information in this file consists of the names, key columns, and number of records in each table, as well as the names, lengths, and data types of each column.

An R:BASE data-table file is comparable to a file in systems such as Ashton-Tate's dBASE; it contains rows and columns that correspond to the records and fields of a dBASE record. An R:BASE database can contain 80 data tables or 800 columns, whichever comes first. A row is limited to 4,096 bytes. The number of rows per table or database is limited only by the DOS limitation on file size. Eight data types are available (see table 1).

A key file contains the indexes for keyed fields. The developer can look at data in this file by listing tables, columns, or keys. R:BASE uses both the data-dictionary and key files constantly during manipulation of the database; these files must be on the same directory as the data file.

TAKING THE EXPRESS

The developer can choose between two user interfaces: the default, a point-and-shoot PBE menu; or the command mode (indicated by an R> prompt), where the user enters R:BASE commands. Selections from the PBE main menu (see photo 1), can be highlighted by pressing the space bar repeatedly, using the cursor keys, or typing the number or letter of the selection. Subsequent PBE menus provide a command-explanation window and command line for selection (see photo 2). The window explains each selection, eliminating any guesswork about what a command does.

When the developer chooses a selection from a PBE menu, R:BASE builds a command by prompting for the necessary elements. For example, choosing Modify Data and then Edit enables the developer to select tabular or form display, sort fields, sort order, and finally, conditional statements. Once constructed, a command can be executed, edited, or aborted. To bypass the PBE hierarchy and enter the command mode, the developer simply has to press Esc at the PBE main menu.

TABLE 1: *Data Types in R:BASE*

TYPE	DESCRIPTION
DATE	30 characters depending upon format.
TIME	20 characters depending upon format.
CURRENCY	23-digit money amount with range of ± $99,999,999,999,999.99.
REAL	Real numbers with 6 digits of precision, with range of $\pm 9*10^{\pm 37}$, stored in binary form. Numbers with 6 or fewer significant digits displayed in decimal form, numbers with more than 6 significant digits displayed in scientific notation.
DOUBLE	Real numbers with 15 digits of precision, with range of $\pm 10^{\pm 307}$, stored in binary form. Numbers with 15 or fewer significant digits displayed in decimal form, numbers with more than 15 significant digits displayed in scientific notation.
INTEGER	Integers with range of ±999,999,999.
TEXT	Alphanumeric data up to 1,500 characters per field.
NOTE	Variable length text column up to 4,092 characters including overhead—net length 4,050 characters.

R:BASE supports all commonly required data types, including text, integer, root, double, currency, and the note type for entering variable-length text fields. The user can define the format and sequence of both the date and time type.

Complete applications can be produced either by entering R:BASE commands in the command mode or by using the EXPRESS modules, which also use the PBE interface and are sophisticated enough to develop moderately complex applications. These modules lead the application developer through the development process with a series of prompts, menus, and forms.

Definition EXPRESS. Although the developer does not need to use Definition EXPRESS to define or modify a database, little is gained by defining a database in the command mode. The Definition EXPRESS module efficiently leads the developer through the process of creating tables, views, and data verification rules—even the most complex database can be defined without having to write a single line of code.

However, a few operations, such as dropping views and tables and using the SQL Grant-Revoke security commands, are missing from Definition EXPRESS. To invoke these operations, the developer must use either the PBE menu or the DEFINE mode (which is signified by a D> prompt) in the command language.

The developer can restructure a database at any time using either the Definition EXPRESS module or the R:BASE commands REDEFINE, ALTER TABLE, DROP, EXPAND, REMOVE, INTERSECT, JOIN, PROJECT, UNION, and SUBTRACT. When redefining existing columns, R:BASE creates a temporary table to effect the modifications, so space must be available for an additional table and column; if the database has reached the limits of 80 tables or 800 columns, restructuring is not possible. For the most part, however, the database can be restructured with single commands. Special conversion utilities are not necessary.

R:BASE automatically verifies data entries according to field type and length. The developer can also create a maximum of 20 data-entry rules per table that can ensure, for example, that all values fall within a specified range, exist in a table, or are equal to a specified value.

A rule can contain 10 conditions, each consisting of a column name, a comparison operator (EQ, NE, GT, GE, LT, LE, CONTAINS, EXISTS, FAILS, EQA, NEA, GTA, GEA, LTA, LEA), and a value or second column. Conditions are connected by the logical operators AND, OR, AND NOT, and OR NOT to form rules. Rules also can display error messages if the data do not pass muster.

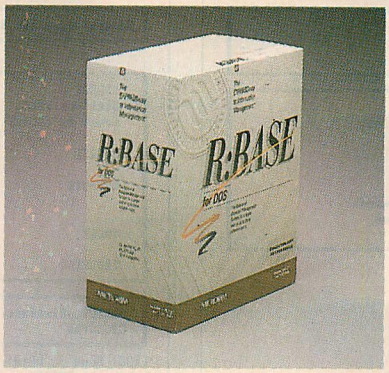
Using Definition EXPRESS, the developer can add or modify data-entry rules at any time, not just when the database is defined. Rules also can be defined in an application or from the Define mode prompt with the RULES statement.

Application EXPRESS. The heart of the application modules, Application EXPRESS is designed to help developers produce menu-based applications, up to three levels deep, that have the same look and feel as R:BASE. Many tasks can be incorporated into an application simply by selecting actions from menus and assigning them to application menu selections. The PBE menu source code, included in the system, can be customized for applications.

R:BASE FOR DOS OVERVIEW

R:BASE for DOS 2.1
Microrim Inc.
3925 – 159th Avenue, NE
P.O. Box 97022
Redmond, WA 98073-9904
206/885-2000
CIRCLE 328 ON READER SERVICE CARD

Product description. R:BASE for DOS is a relational database management system, which includes a procedural programming language, application generators, and utilities.
IBM PC environment. IBM PC, PC/XT, PC/AT, and PS/2; DOS 2.0 or later for single-user applications; DOS 3.1 or later for local area networks; 512KB of RAM for single-user installations; 640KB of RAM for local area network installations; color or monochrome monitor and display adapter; one 10MB hard disk and one diskette drive, or two 1.44MB 3.5-inch diskette drives; dedicated file server required for local area networks.
Other environments. PC-, XT-, and AT-compatible machines.
Network support.
Hardware: IBM PC Network, IBM Token-Ring, 3Com EtherLink, EtherLink Plus, Ungermann-Bass.
Software: IBM PC Network program, Novell Advanced NetWare, IBM PC LAN program, 3Com 3+.
Copy protection. None.
Documentation. Manuals range from step-by-step tutorials for new users and developers to brief summaries for experienced users and developers. They include *Learning Guide, User's Manual, Building Applications/Command, Dictionary, Installation and Startup Guide, Supplement, Command Summary, Worksheets, Error Messages.*
User interface. Screen menus with prompts, screen forms and tables, and command line are available to both developer and end user.



Help facilities. On-line context-sensitive help screens are available to the developer and can be incorporated into applications.
File capacities. Three files constitute a database: dictionary, data, and index. A database can contain 80 tables and 800 columns or fields. A table can contain an unlimited number of rows or records, and each row can be 4,096 bytes in length; text fields are limited to 1,500 bytes. The entire database is limited by operating system and hard-disk capacity.
Field types/capacities. DATE, TIME, CURRENCY (amounts with range of ±$99,999,999,999,999.99), REAL, (real numbers with 6-digit precision), DOUBLE (real numbers with 15-digit precision), INTEGER (integers with range of ±999,999,999), TEXT (as many as 1,500 characters per field), NOTE (variable length text with a 4,092-character limit including overhead—net length 4,050 characters).
Data entry. Data manager checks data type automatically. Developer can define data-entry rules to check ranges, perform table look-ups, and compare data to logical expressions.
Application development facilities. Procedural programming language includes all of the R:BASE commands; GOTO <*label*>, If . . . Else . . . Endif, Set Pointer, While . . . Break . . . Endwhile flow control statements; SET (environment) statements; math and string functions; typed global and error variables; parameter passing to command and procedure files; multiuser environment control. Definition EXPRESS, Application EXPRESS, Forms EXPRESS, and Reports EXPRESS constitute the application generator. Companion products include DB Graphics, CLOUT, Extended Report Writer, Program Interface (for Microsoft C, Pascal, and FORTRAN), and Runtime packages.
Security. Passwords can be assigned to databases, tables, and views.
Querying and sorting. Virtually all R:BASE commands can be used to query the database. Ad hoc queries require a working knowledge of the command language and relational operators when entered at the command prompt. Prompt-by-example Mode guides the user through queries or other R:BASE commands.
Reporting. Reports up to 255 characters wide, with report and page headers and footers, up to 10 breakpoints with optional headers and form feeds, and automatic pagination. Reports EXPRESS provided for report generation.
Utilities. Screen editor; EXPRESS application generator modules.
Data compatibility. Import/export of ASCII fixed-length records, ASCII-delimited records, Lotus 1-2-3 worksheet files, Symphony worksheet files, .DIF files (VisiCalc, TK!Solver), Multiplan SYLK files; import of dBASE II, dBASE III .dbf files and pfs:FILE. With Lotus's The Application Connection (T-A-C), exchange files with mainframe systems: Ramis II, FOCUS, SAS, SQL/DS, NOMAD2, IC/1, ADRS II, APLDI, CMS, QSAM.
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Support. Telephone support for 30 days free and through Software Maintenance Plan thereafter.

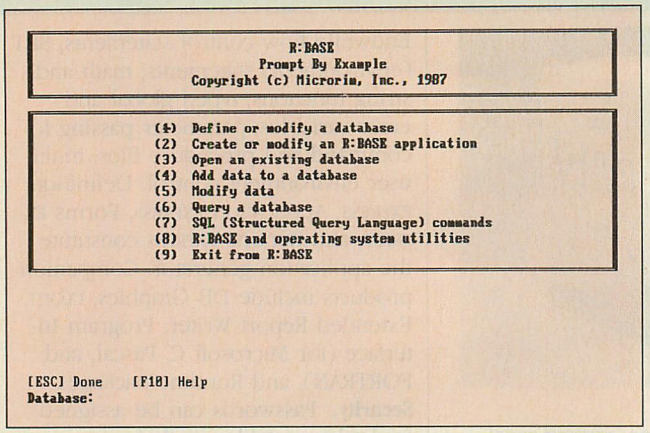
—Victor E. Wright

With Application EXPRESS, the developer easily can build multilevel menus. Horizontal menus can have as many as 12 options of 10 characters each. (Similar menus built outside of the module can have 81 eight-character options.) Vertical menus are numbered lists of as many as nine options, each with a maximum length of 60 characters. After menu definition is complete, the module prompts the developer to type a custom help screen with a maximum of 750 lines of text; the user can display this screen by pressing the F10 key. It is unfortunate that Microrim selected F10 because the F1 key is the proposed standard for help.

Custom help screens can be linked to screen menus, which are displayed by pressing F10. As the developer defines each menu, the module asks if a help screen is desired; if the answer is yes, it invokes RBEDIT to create the help screen. Help text is paged automatically if it exceeds 20 lines. If the F10 key is pressed while a data-entry form is displayed, it displays a general help screen that describes the commands available from the ENTER command menu.

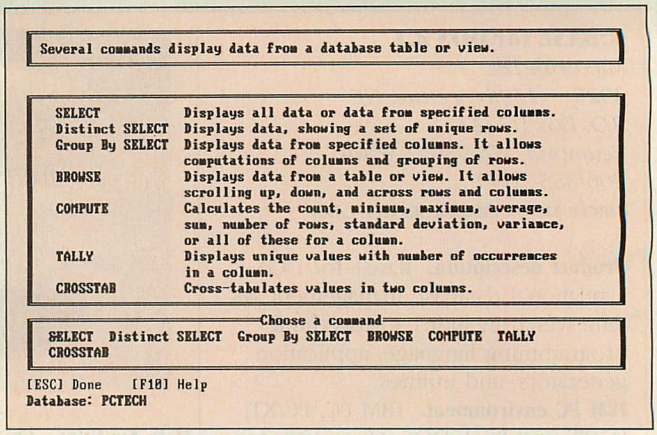
Existing command files also can be assigned to a menu selection from within Application EXPRESS. The *macro* action prompts for an external file and inserts it as a command block. The term macro is appropriate because the

PHOTO 1: *R:BASE PBE Menu*



The point-and-shoot interface of R:BASE's PBE menu is operated with the space bar and Enter key, arrow keys and Enter key, number keys and Enter key, or the mouse.

PHOTO 2: *Sample PBE Screen*



A typical PBE screen displays a list of commands that can be executed, a summary of the capabilities of a group of commands, and a detailed message about each command.

external file is copied into the application file—the application does not "call" the external file.

A *template* file can be assigned to a menu selection. A template is a generic program that Application EXPRESS uses to generate a specific command block. As many as nine placeholders (such as table names, column names, and variables) can be defined in the template file. As Application EXPRESS reads in the template file, it prompts for the actual values, which it then substitutes for the placeholder. Thus, a developer might create a generic order-entry command file, in the form of a template file, which then can be used to generate order-entry command blocks for specific businesses.

The point-and-shoot programming method is best suited to linear tasks—for example, inquiring about the credit status of a customer, entering data on an order-entry form, printing an order picking report, and printing the invoice and packing list. Such sequences are constructed by selecting a series of supported commands from a menu and answering the prompts.

For more complex tasks, such as breaking an assembly down into component parts for production scheduling in an material-resources planning (MRP) system, the developer must resort to programming with the text editor. Application EXPRESS does not provide a method for specifying operations that require program constructs such as If . . . Then or While . . . Endwhile statements. However, the module does provide alternatives.

One of the actions that can be assigned to a menu selection is Custom. Making that selection for a menu action merely invokes RBEDIT, so that a series of commands can be entered into a command block that is inserted into the application file.

Forms EXPRESS. Once an application's structure is defined, data-entry forms can be customized to perform editing functions and table look-up using Forms EXPRESS. The developer creates forms by typing labels and drawing borders on the screen, filling in form characteristic tables, and locating fields (see photo 3).

As with Application EXPRESS, the developer can create data-entry forms without having to write a single line of code. Text is typed in, and fields are located with the function keys.

Forms EXPRESS accommodates the creation of forms with multiline regions that display several rows (records) from a database. It allows the creation of forms as big as five screens in length; each screen can contain as many as 22 lines. A form also can display and update records from a maximum of five different database tables simultaneously.

Reports EXPRESS. With Reports EXPRESS, the developer can draw custom reports on the screen with detail lines and headers and footers for reports, pages, and breakpoints. Although a report is based on a single table or view, called the driving table or view, data can be gathered from other tables as long as each has a column in common with the driving table or view. This relational linkage allows the construction of multiline reports that display data using one-to-many relations—the driving table supplies a value on the one side, and R:BASE finds all the rows on the many side.

Printer control in Reports EXPRESS is accomplished through the use of report variables. A printer-control variable is defined as the decimal values of the required control characters and/or escape sequences that are enclosed in angled brackets (< >) and located in a report field. When the report is printed, the contents of the field are sent to the printer.

Because the custom forms and reports generated with Forms EXPRESS and Reports EXPRESS are easily incorporated into applications generated with Application EXPRESS, most developers will forego the more primitive default forms and reports produced by Application EXPRESS. The default form is simply a screen containing a line for each column (field), with the column name as a label. Default reports are of two types—a columnar report containing a title, column headings, and data in columns, and a row report in which each row appears with each column in a separate line, with rows separated by blank lines. When the user specifies a form or report, Application EXPRESS prompts the user to choose either the default or custom form or report.

Once the application is complete, Application EXPRESS invokes the RCOMP compiler to produce an executable program. Application EXPRESS produces an ASCII version of the file in addition to the compiled version of the program, so that the program can be customized if desired. Just as in earlier R:BASE products, the ASCII file for an application developed under Application EXPRESS can be edited to add or change features, but once edited outside of the module, the user cannot change it again using the module.

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MEDIA INTELLIGENCE

BPA

PHOTO 3: *Form Definition*

```
                    Form Definition Menu
 Edit  Expression  Customize  Draw

                                                              E
    Title: S
   Author: S                E S          E  Day Phone: S        E
Co-author: S                E S          E

  Booking: Volume S  E  Number S  E
     Date: S       E S  E

Article Type --  Category: S                E
                 Department: S                  E

 Date Due: S                E    Date Received: S            E

     Sizes -- Editorial:  S      E  Payments -- Article: S      E
              Listings:   S      E             Bonus:   S      E
                 Total:   S      E             Total:   S      E

[ESC] Return  [F3] Review  [F7] Prev table  [Shift-F10] More
Form: ARTICLE1                        Table: ARTICLE
```

The user types in text and draws boxes to create forms with the Forms EXPRESS module. Each form can display and update information from five database tables.

PHOTO 4: *Constructing a Query with PBE*

```
SELECT TITLE AU_LNAME AU_FNAME VOLUME NUMBER FROM ARTICLE WHERE ...

Choose an operator to combine conditions - Choose (Done) when done
AND  OR  AND NOT  OR NOT  (Done)

|  | Column | Operator | Value |
|  | CATEGORY | EQ | Directions |

[ESC] Done  [F10] Help
Database:
```

A complex command can be constructed quickly with the use of the PBE point-and-shoot interface—only the value "Directions" had to be typed in from the keyboard.

Application EXPRESS maintains three files for each application generated. The definition of the application is contained in a nonreadable file with an .API extension. The code generated is contained in ASCII form in a file with an .APP extension. Finally, the executable version is contained in a binary file with an .APX extension; Application EXPRESS invokes CodeLock to produce this file after it generates the code.

The .APP file can be examined with the TYPE command, from DOS or R:BASE, and edited with a suitable editor—RBEDIT may not be suitable for editing an entire application, as it is limited to 750 lines. However, Application EXPRESS always reads the .API file not the .APP file to retrieve the current definition of an application. Changes made in the .APP file outside of Application EXPRESS are not reflected in the .API file and will be lost the next time Application EXPRESS is used to modify the application.

SPEAKING IN R:BASE

Without question, developers can use R:BASE EXPRESS modules to develop complex, real-world applications. At some point, however, serious developers will find that they have to resort to writing R:BASE code or modifying code gener-

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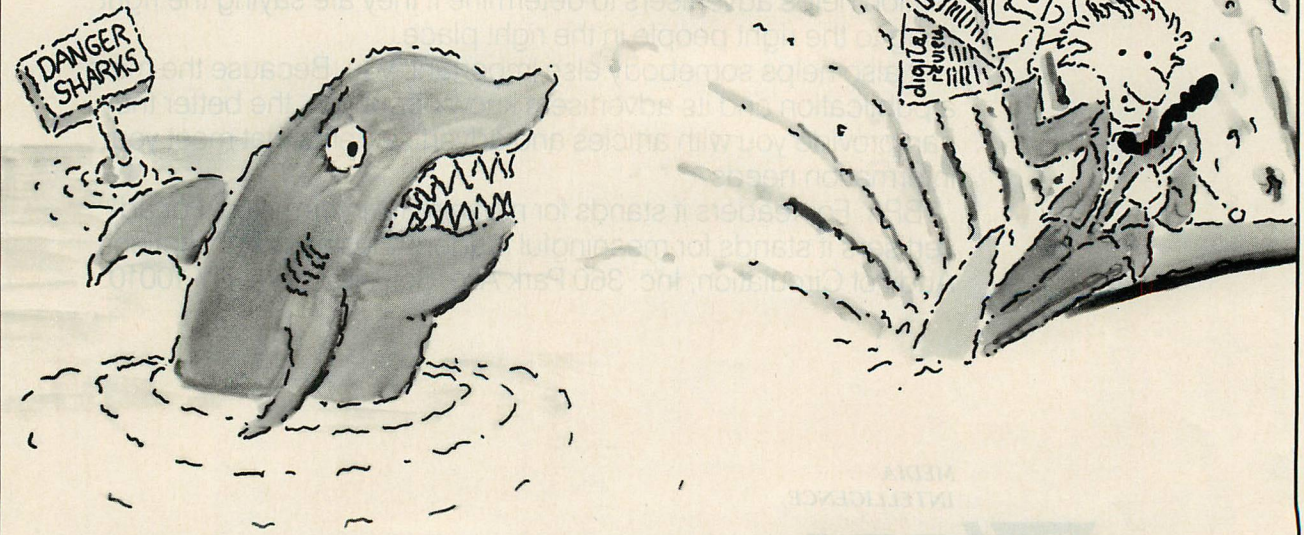

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ated by the modules. However, the R:BASE modules can be used very effectively to prototype and maintain an application—Application EXPRESS is a particularly effective code generator and manager. Customized code is easily integrated into the code generated by the system.

The R:BASE command language offers the developer three types of control structures. The If . . . Endif construct permits conditional execution, allowing both If . . . Then . . . Endif and If . . . Then . . . Else . . . Endif statements. The While . . . Endwhile construct allows looping with a test at the top of the loop, but R:BASE does not support a Repeat . . . Until structure for loops that test at the bottom. The R:BASE GOTO and LABEL statements are the developer's classic solution to any flow-control problem, and the BREAK statement can be used to break out of a WHILE loop.

As with earlier R:BASE products, nesting of control structures is limited to 10 levels for both If . . . Endif and While . . . Endwhile constructs and to a total of 20 levels. Command files can be nested to 5 levels.

R:BASE supports both global and error variables; however, it does not support local variables. The number of global variables is limited only by available memory, whereas the number of error variables is limited to one general error variable at a time and three to be used when accessing rows. Variable names can be no more than eight characters. Global variables can assume any legal data type and can be typed implicitly or explicitly. Error variables are integer variables.

The lack of local variables makes it wise to clear all variables quickly because those used in one command file cannot be hidden from others.

Parameters are a special variable type, referenced by position in the command file call. Nine parameters can be passed to a command file invoked with the Run . . . Using command. Parameters exist for the duration of command file execution and do not have a preset data type; global variables, which must have a specific data type, exist until cleared or until execution is complete. R:BASE has no provision for user-defined functions that return values to the calling statement; values must be returned through global variables.

R:BASE has a set of predefined SuperMath functions—arithmetic and mathematical, trigonometric, data-type conversion, string manipulation, date and time, financial, and logical. These functions, unchanged from System V, can be included wherever expressions are permitted and can calculate values for computed fields or for variables, modify the values of columns, and calculate values to display in reports. In some, but not all, cases, functions can be used in expressions in the WHERE clause of a SELECT command.

Keys in R:BASE are maintained automatically in a single file, which is created when the database is defined. Key indexes can be added to the database with the BUILD KEY and CREATE KEY commands and then deleted with the DELETE KEY and DROP KEY commands. Although reorganizing the database is not necessary when key indexes are added or removed, compressing the database using the PACK command is recommended; this reclaims the unusable space created by removing key indexes. Keys speed data retrieval operations but are not required.

The developer can customize the application by altering the key-word settings that control various operational aspects of R:BASE applications. Useful

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key words include AUTOSKIP (to move the cursor to the next field automatically during data entry), BELL (to sound a bell), MESSAGES (to display system messages), and RULES (to check input against all rules). Other key-word settings include those that control screen foreground and background color, currency symbols, date format and sequence, time format and sequence, lines per page or screen, the character to display for null values, tolerance for real-number comparisons, the number of columns to display per page or screen for SELECT output, and user passwords. Entering the SET command at the R> prompt or from the PBE menus displays a full-screen status report. The user can modify all special character and key-word settings from this screen. Alternatively, single values can be set by entering SET followed by the parameter and new value.

STRUCTURING AN APPLICATION

The basic type of R:BASE command file defined by the EXPRESS modules or command language is the *procedure* file, which can contain 42 command, menu, or screen blocks, each of which consists of a command and optional key words and arguments. The Command blocks are identified by the $COMMAND key word followed by an 8-character name. Like subroutines, command blocks are executed only with a RUN <*name*> command. Menu blocks (menu definitions) are identified by $MENU and an 8-character name. They are invoked from a procedure file with the CHOOSE <*name*> command. Screen blocks that describe screens to be shown to the user are identified by $SCREEN and a name; they are invoked using the DISPLAY <*name*> command.

An application can comprise a single command file or a main file that calls other command files, just as general-purpose programming languages allow structuring a program into a main routine and several subroutines. Whether the command file is produced with a text editor or Applications EXPRESS, an R:BASE program must include statements to set the program's environment, open the database, and create variables. Before a procedure file can be executed, it must be translated into binary form, encoded, or compiled.

Microrim offers a companion product, Program Interface, that allows programs written in Microsoft C, Pascal, and FORTRAN to directly access (load, add, delete, modify, and retrieve) R:BASE data. These routines can be linked in non-R:BASE programs.

R:BASE executes application programs in several forms—ASCII, a binary form produced by the CodeLock utility, and a compiled form produced by RCOMP or Application EXPRESS. However, neither CodeLock nor RCOMP produce stand-alone, executable programs. All three forms require the R:BASE program, which interprets the application program. A runtime package, R:BASE RUNTIME, is available to permit distributing applications without requiring the end user to purchase a full R:BASE development package. Each runtime package includes five licenses.

Small programs can be executed with R:BASE still in memory while larger programs require the developer to exit R:BASE to release sufficient memory. The ZIP ROLLOUT command saves the R:BASE environment before the developer executes the external program, so that the R:BASE environment can be restored when execution is complete. ZIP can pass command-line arguments, but it cannot be used to execute DOS internal commands. COMMAND.COM can be loaded to execute batch files.

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TABLE 2: *Methods for Entering R:BASE Commands*

PBE MENUS AND COMMAND MODE			
ALTER TABLE	Distinct SELECT	INTERSECT	REPORTS
APPEND	DROP	JOIN	RESTORE
BACKUP	EDIT	LIST	REVOKE
BROWSE	EDIT USING	LOAD	RMDIR
BUILD KEY	ENTER	MKDIR	RUN
CHANGE	ERASE	OPEN	SELECT
CHDIR	EXIT	OUTPUT	SET
CHDRV	EXPAND	PACK	SHOW
CHKDSK	EXPRESS	PRINT	SUBTRACT
CLOSE	FORMS	PROJECT	TALLY
CODELOCK	GATEWAY	RBDEFINE	TYPE
COMPUTE	GRANT	RBEDIT	UNION
COPY	Group By SELECT	REDEFINE	UNLOAD
CROSSTAB	HELP	RELOAD	UPDATE
DELETE	INPUT	REMOVE	USER
DIR	INSERT	RENAME	VIEW
			ZIP
COMMAND MODE ONLY			
BEEP	DECLARE CURSOR	NO CHECK	SET POINTER
BREAK	DEFINE	NO FILL	SET VARIABLE
CHECK	DISPLAY	PAUSE	SET VERIFY
CHOOSE	FETCH	PLAYBACK	SET WAIT
CLEAR	FILLIN	PROMPT	SHOW ERROR
CLS	GOTO	QUIT	SHOW VARIABLE
* (COMMENT)	IF...ENDIF	RECORD	WHILE...ENDWHILE
CREATE INDEX	LABEL	RETURN	WRITE
CREATE TABLE	NEWPAGE	SET ERROR	
CREATE VIEW	NEXT	SET LOCK	

R:BASE for DOS offers commands for data definition, data manipulation, and program control, as well as several SQL commands that are new to this version.

The developer can perform routine file management without leaving R:BASE, either from the PBE menu or the R:BASE command prompt. Commands to manage disks, directories, and files include CHDIR, CHDRV, CHKDSK, COPY, DIR, ERASE, MKDIR, RENAME, RMDIR, and TYPE. The TYPE command provides a general method of displaying text files from the R> prompt or from the PBE menu and automatically pages files longer than 20 lines. Both TYPE and DISPLAY, which displays text on the screen, can be used to present instructions to the end user. Specifically, DISPLAY is used in conjunction with the CHOOSE command, which displays menus and branches to the appropriate routines. TYPE also pages the typed file. External programs can be executed with the ZIP command; a ROLLOUT option releases memory to permit the execution of large programs. These capabilities are all unchanged from System V.

Debugging tools are limited to messages, error messages, and command echo. Debugging an R:BASE program is a matter of programming technique and includes variables to store key values, statements to display key values and messages, pause statements to halt execution at key points, and echoing commands so that execution can be traced.

Program optimization is also largely a matter of programming technique. The manual lists a few rules to follow—such as using abbreviations for commands, grouping like commands, using While statements instead of If . . . Then statements, using only forward references—but tools for optimizing code are not provided. Execution speed can be improved by compiling an application with CodeLock or Developer's EXPRESS.

R:BASE includes no utilities for recovering damaged database files. The documentation does not mention the possibility of damage in any of the manuals, except in the context of restoring the database from backups. Nevertheless, R:BASE does perform some automatic recovery. If a key index file is erased, R:BASE will create the file the next time the database is opened. The new key file is empty, but building a new key, or a key that was present in the deleted file, rebuilds the entire key file. Similarly, a pack operation will recreate the key file.

PBE KEEPS IT SIMPLE

With PBE menus, end users need not see a line of R:BASE code—even casual users can query the database effectively. As options are selected, PBE displays commands as it constructs them and allows editing before execution (see photo 4). Users can construct most, but not all, R:BASE commands with the arrow keys, space bar, Enter key, and Esc key. Table 2 lists the commands available through the PBE menu and the R:BASE command line.

The SELECT command displays all or part of a table or view, with options to display only unique rows or to group rows; BROWSE displays multiple rows and allows scrolling; COMPUTE calculates statistics; TALLY tabulates unique values; and CROSSTAB cross-tabulates data in two columns. Although R:BASE has no SORT command, rows can be sorted on as many as 10 columns and selected with a WHERE clause consisting of multiple conditions. Effective use of these commands requires a thorough knowledge of the language and more than a casual knowledge of database principles.

To create new tables or new views from existing tables, the developer uses R:BASE's relational commands such as, APPEND (to add rows from a source table or from a view to a destination table); JOIN (to combine rows in two tables based on a comparison of values in two columns); and VIEW (to combine up to five tables having identical values in matching columns. In addition, the developer can create views using the SQL CREATE VIEW command.

Data can be retrieved from both single- and multitable views but can be updated only in single-table views. The developer also can retrieve data from two tables by nesting SELECT commands or by selecting from views created by the relational commands.

R:BASE for DOS also includes a subset of SQL commands—CREATE TABLE, ALTER TABLE, DROP, INSERT, UPDATE, DELETE, DECLARE CURSOR, FETCH, GRANT, and REVOKE Some are aliases for commands that already existed in previous versions. For example, DECLARE CURSOR is the SQL equivalent of the R:BASE System V SET POINTER command. SELECT has been extended to include SQL syntax and

the forms DISTINCT and GROUP BY. The end user can select some SQL commands from the PBE menu. Others, such as CREATE INDEX, CREATE TABLE, and CREATE VIEW, must be entered from the command line (see table 2). Effective use of SQL commands from the command prompt requires more knowledge than the nontechnical user may possess (see the accompanying sidebar on SQL below).

To enter and update data, the user who knows the database structure can add or modify rows in one table at a time, using the LOAD command or the SQL INSERT command from the command line. Those less familiar with the database structure should enter rows one column at a time (R:BASE prompts for each column) by using the LOAD command with the WITH PROMPT option. LOAD can also be used to import data from an ASCII-delimited file.

The CHANGE command can update several tables at once, changing a value wherever it appears. Alternatively, customized or default screen forms can be used to add, edit, or delete data in five tables at once.

UTILITY PLAYERS

R:BASE for DOS includes a number of useful utilities to transfer data, speed execution of an application, edit text, and perform other tasks. The R:BASE utility program FileGateway transfers data directly between R:BASE and other data managers and similar programs. It can be executed from the PBE menus, from the R:BASE prompt, or from the operating system prompt. Data can be imported directly from Lotus 1-2-3 and Symphony, dBASE, SYLK (Multiplan), DIF (VisiCalc), pfs:FILE, and ASCII files. Data can be exported to all but dBASE II and pfs:FILE.

Through FileGateway, R:BASE supports Lotus's The Application Connection (T-A-C) file format and can upload to and download from mainframes. FileGateway imports data into an existing table or creates a new table, in which case the utility examines the first record in the file to be imported and sets default column characteristics accordingly. It then displays the first record and the File Conversion Editor menu. The user can change the structure before importing the data.

Whether the imported data are added to an existing or new table, FileGateway examines each record to determine if it fits the table structure. If so, it is added to the table; if not, it is added to an exception table. When the file has been imported, the Exception Handling Editor menu is displayed and allows the user to edit apparent errors and then add or discard the record.

INTEGRATING SQL FEATURES INTO R:BASE

Because Structured Query Language (SQL) is becoming accepted as the standard data management language in the industry, most vendors are integrating it in one form or another into their products. Microrim opted to introduce selected features of SQL into its newest version of R:BASE—R:BASE for DOS. Although a partial implementation such as this can be justified as meeting current user needs or phasing users into SQL, it forces the user to simulate missing functions by writing many SQL statements or procedural code.

The R:BASE data definition language (DDL) includes the CREATE TABLE, CREATE INDEX, and CREATE VIEW commands defined in the ANSI SQL standard. The CREATE TABLE command supports data types that are similar to but different from those in the standard—TEXT rather than the standard CHAR, for example. The functionality of the R:BASE DDL commands is the same, but future compatibility with other SQL implementations is jeopardized.

To guarantee the uniqueness of each row in a table (entity integrity), the developer must define a unique compound key (an index on more than one column). For example, a key in a parts table may be a combination of part number and size. R:BASE's CREATE INDEX command does not support unique or compound indexes. The CREATE TABLE statement does permit the specification of a unique column, but only on single columns. Thus, defining a unique compound key is not possible in R:BASE's SQL. In addition, neither ascending nor descending indexes can be defined.

Views in R:BASE are limited to five tables that can be joined on similarly named columns. In ANSI and IBM SQL, SQL statements can include any number of joins, subqueries, groupings, unions, and combinations of these statements.

R:BASE's views greatly limit the potential of the view concept, which is meant to provide logical data independence. For example, a user who wishes to see only a count of parts can access a view that was created using the following SQL command:

```
CREATE VIEW parts_totals
            (part_no, count)
AS SELECT part_no, count(*)
FROM parts GROUP BY part_no
```

A user can then select the count of a particular part by:

```
SELECT part_no, count
FROM parts_totals
WHERE part_no ='1'
```

This type of view, which is more useful because end users do not have to be concerned with the GROUP BY clause, is not possible in R:BASE.

The heart of SQL's data manipulation language (DML) is the SELECT command. R:BASE supports a SELECT statement with limited capabilities and limited support for subqueries (nested queries). In R:BASE, a subquery requires the IN operator and is limited to only one level. An example of this type of query is to find all employees in the employee table that are not in the payroll table:

```
SELECT employee
FROM employee_table
WHERE employee_number NOT IN
        (SELECT employee_number
         FROM payroll_table)
```

R:BASE cannot handle subqueries involving more than two tables nor subqueries requiring mathematical operations or the EXIST and NOT EXIST operators. For example, the following SQL query (to find all employees whose salary is greater than the average of all employees in the company) is not possible with R:BASE's implementation of SQL:

```
SELECT employee_name
FROM employee_table
WHERE salary >
        (SELECT AVG(salary)
         FROM employee_table)
```

Correlated subqueries (for example, to find all employees in the company whose salary is greater than the average salary in one department) and subqueries in INSERT, DELETE, and UPDATE commands are also missing from R:BASE. Subqueries are important in INSERT commands to allow users to move data between tables with one set-oriented command:

FileGateway is not limited to importing data from external files into tables of identical structure. The utility includes a File Conversion Editor for changing the name, type, and length of a field as the data are imported.

The R:BASE utility RBEDIT is a full-screen text editor for use in creating custom command files, help screens, and other text files. It can be invoked from the PBE menu or from the DOS or R:BASE command line. Application EXPRESS automatically invokes RBEDIT for creating help screens and custom command files. RBEDIT can be used to edit files with as many as 750 lines, but it contains only the most basic text editing commands: insert a blank line or character; delete a line, character, or block of characters; copy a block; and the usual cursor-movement commands. Although it is no substitute for a word processor or programming text editor, RBEDIT is suitable for creating short and simple R:BASE command files. As an alternative, the developer also can write R:BASE command files with any text editor or word processor capable of generating ASCII files.

R:BASE provides two utilities for improving the execution speed for an application: CodeLock and Developer's EXPRESS. Both are menu driven and easy to use. CodeLock converts ASCII program files (including any command, screen, and menu files) to binary form that can be executed more efficiently because CodeLock parses R:BASE commands prior to the execution stage and eliminates the need to open and close files during execution. Developer's EXPRESS also creates binary files but goes a step further. It preprocesses the program, performing selected tasks during the compilation process and reducing the need for performing those tasks during execution. For example, the compiler checks syntax, converts computed references in loops and conditionals to absolute references, and provides a means to retain references to tables, columns, variables, and labels during execution.

The 3Labels utility is a bonus for users requiring mailing labels. It extracts data from a database table and arranges it in two different label formats; the labels can be selected conditionally and sorted on 10 fields.

HELP IS AT HAND

R:BASE for DOS 2.1 includes 11 360KB 5.25-inch diskettes, nine 720KB 3.5-inch diskettes, four perfect-bound manuals, and several abbreviated manuals. Through tutorials, the *R:BASE Learning Guide* teaches the basic principles of relational database design. It presents information on how to query an exist-

```
INSERT INTO new_table
  (employee_number, employee_name)
    SELECT employee_number,
           employee_name
    FROM employee_table
    WHERE salary > 50000
```

R:BASE's SQL has some other annoying anomalies. A SELECT DISTINCT operation cannot contain an ORDER BY clause, and the ORDER BY clause does not permit ordering that is based upon the position of a column in column_list. The following SQL statement is not valid in R:BASE:

```
SELECT salary * 1.1, employee_name
FROM employee_table
ORDER BY 1
```

The 1 refers to the expression that multiplies salary by 1.1. R:BASE does not allow this type of ordering on an expression or aggregate function (for example, AVG, MAX, MIN, SUM, and COUNT).

While R:BASE supports the GROUP BY clause, it is missing the complementary HAVING clause used to eliminate groups from results. The following command finds all managers who have more than 20 employees:

```
SELECT manager_name
FROM employee_table
GROUP BY manager_name
HAVING COUNT(*) > 20
```

The GROUP BY clause groups all instances of a manager's name. The HAVING clause looks at each group and counts the number of times the name appears. If less than or equal to 20, it is eliminated from the result.

R:BASE supports null values as well as the IS NULL and IS NOT NULL operations in the WHERE clause of a SELECT. However, R:BASE's EXISTS operator, which returns true if the column has a non-null value, is identical to the IS NOT NULL and should not be confused with the SQL EXISTS operation, which tests whether a row is returned by a subquery. Although EXISTS is used rarely in an interactive session, it is valuable when used to test for a true or false condition.

R:BASE has a variety of relational operations including JOIN, PROJECT, UNION, and INTERSECT. These operations are not the same as their relational counterparts and cannot be used in SQL statements. They create permanent tables. For example, the relational UNION merges the results of two queries:

```
SELECT employee_name
FROM permanent_employees
UNION
SELECT employee_name
FROM temporary_employees
```

This query lets users extract results from two tables and merge those results into a virtual table that can be displayed interactively or used or manipulated in a program. R:BASE's UNION is completely different. It is equivalent to a relational outer join and builds a new table from two tables by combining rows with identical values in a common column.

R:BASE's INTERSECT is similar to the relational intersect, which finds all values in one table that exist in another table. Similar to an inner join, R:BASE's INTERSECT achieves the same goal by eliminating all values in one table not found in a second table. SQL supports an unlimited number of tables in a join; the R:BASE JOIN can join only two tables.

R:BASE does not support the SQL COMMIT and ROLLBACK statements that are needed to ensure transaction integrity in both single- and multiuser environments. Partial updates caused by incomplete transactions can damage base tables and indexes; therefore, they should be backed out automatically. Unfortunately, only a handful of PC data managers support this very important function. All full SQL implementations include COMMIT and ROLLBACK support.

R:BASE supports both GRANT and REVOKE. These two privileges can be applied to tables and views. Given the limitations of views, the GRANT and REVOKE options are not as powerful as they could be, but they do supply a good degree of security.

Because R:BASE supports only a portion of SQL's functionality, users must write awkward, time-consuming procedural code. This affects productivity, performance, usability, flexibility, and maintainability.

—Richard Finkelstein

ing database, build a new database, create input forms, enter data, create and print reports, write applications, and import data.

The *User's Manual* is organized by subjects such as data entry and database, form, and report definition. The organization is not quite parallel with that of the program's main menu, but it does reflect a reasonable sequence of application development tasks.

The *Building Applications/ Command Dictionary* and *Command Summary* are the two manuals that the experienced developer or user will want to keep handy. The Building Applications section is organized by topic, covering both the use of Applications EXPRESS and programming directly in R:BASE. The Command Dictionary section lists all R:BASE commands in alphabetical order. The description of each command includes the syntax, a statement of the command's purpose, a description of options, and comments, examples, and references to related commands as well as to other parts of the documentation.

On-line, context-sensitive help is available at all times. Pressing the F10 key displays a help screen describing the command or menu selection currently highlighted. If a command is in progress or is highlighted, the syntax is displayed in the same format used in the reference manual—in fact, the display is almost identical.

MANAGING A CROWD

The basic R:BASE system can be installed as a multi- or single-user system. The SET command includes a MULTI toggle to allow switching between the two modes. The default configuration file can be modified to start up R:BASE for DOS in the desired mode.

R:BASE automatically performs table and database locking to prevent overlapping updates. The type of lock applied depends on the operations involved. If an ongoing operation affects the entire database, then it is locked; if it affects a single table, then only that table is locked.

R:BASE also resolves the conflict of two or more users attempting to modify the same column in the same row by using concurrency control—the first request is accepted, but the second user is notified that the database has just been changed. With the SET VERIFY command, the developer can force R:BASE to check for conflicts in a

A CLOSER LOOK AT R:BASE FOR OS/2

Microrim was one of the first firms to make a commitment to OS/2. R:BASE for OS/2 is a reliable package that lets the user take advantage of OS/2's multitasking capabilities. In addition, applications developed under either R:BASE version can run under either operating system—a definite plus for the application developer.

Although the two versions are almost indistinguishable in look and function to both the user and developer, they are not identical; R:BASE for DOS is heavily overlaid, whereas R:BASE for OS/2 is a single program. However, both versions consist of the same R:BASE programs and utilities that are invoked from the R:BASE R> prompt or the PBE menus. Because OS/2 uses the same file structures that DOS uses, R:BASE for OS/2 has the same limitations on database size that the DOS version has. (For an inside look at how Microrim converted its R:BASE System V product to IBM's new operating system, see "Porting to OS/2," Steven Armbrust, November 1987, p. 140.)

The R:BASE developer has an advantage over developers using other data managers because a single application can be developed that will run under either DOS or OS/2. In fact, the user can develop an application with one version, modify it with the other, and run it using either version.

R:BASE for OS/2 also allows the user and developer to take advantage of OS/2's multitasking capability. The user can recall the OS/2 program selector at any time to start a new program. Alternatively, the user can select other programs already running with the Alt-Esc key combination.

In addition to running R:BASE and one or more programs concurrently, several instances of R:BASE, using the same or different databases, can be run. R:BASE for OS/2 allows this by using the same concurrency controls that it applies to a database in a network environment.

Installing R:BASE for OS/2 was not without incident. On the first attempt, R:BASE simply would not run, reporting that insufficient memory was installed, even though the Model 80 host had 2MB of RAM. Repeating the installation procedure did not correct the problem.

A call to Microrim eventually uncovered the cause. While OS/2 uses 1MB of RAM, configuring OS/2 for a DOS compatibility box uses an additional 640KB of RAM. The amount of RAM left is not sufficient for R:BASE, even though OS/2 is a virtual system. Either installing more RAM or reducing the size of the DOS environment by about half enables R:BASE for OS/2 to run without difficulty.

Further experimentation led to another RAM problem, however. Even with OS/2 configured without a DOS environment (PROTECTONLY = YES), only one copy of R:BASE could be started. Thus, the developer who wishes to take advantage of OS/2 multitasking by working on a dozen applications at once should be prepared to install additional RAM, over and above the minimum required by OS/2 (1.5MB RAM for protected mode only, 2.0MB RAM for protected and real mode).

Those who have used OS/2 will not be surprised to find that R:BASE hesitates at times—the hesitation is just barely noticeable and is undoubtedly a consequence of OS/2's housekeeping chores. For the most part, though, R:BASE for OS/2 operates at the same speed as R:BASE for DOS.

R:BASE for DOS can run under OS/2 in the DOS compatibility box. It operates the same in the compatibility box as it does in any DOS environment, once some adjustments are made to the OS/2 default environment. For example, if R:BASE detects a mouse driver, it automatically takes advantage of the mouse. The OS/2 installation program prompts for a mouse and modifies the CONFIG.SYS file appropriately. However, this default installation activates the mouse only for the OS/2 mode; a DOS mouse driver cannot be installed under the DOS compatibility box. Thus, R:BASE ignored the mouse under that environment. Similarly, using a serial printer in the DOS compatibility box requires some adjustments—SETCOM40 must be used to set the COM port address.

The bottom line is that the end user who selects R:BASE for OS/2 benefits more from OS/2's multitasking abilities than from any enhancements in the data manager. This alone, however, is reason enough to purchase both R:BASE for OS/2 and OS/2 itself.

—Victor E. Wright

single column or an entire row. This method corresponds to record locking. Concurrency control denies neither read/write access to other rows of the table or other tables of the database nor read access to the database, even to the locked rows or tables.

On occasion, two users may attempt to update the same two tables. In order to complete the operation, each user must update one table and then the other, but in opposite order. Each user locks one table and waits for the other to be released—this situation is called *deadlock*. R:BASE detects deadlock and corrects it automatically with a prescribed waiting period. If R:BASE cannot complete an operation within a specific time period, it cancels the operation. The developer can set the waiting period within a range of 1 to 16,383 seconds (4.55 hours). The default waiting period is 4 seconds. If the automatic controls do not provide a suitable comfort level, the developer can include commands in the application to set locks explicitly on a list of tables using the SET LOCK <*tables*> ON/OFF command.

Microrim includes two security systems in R:BASE: a Read-Modify system (compatible with earlier R:BASE versions) and the SQL Grant-Revoke system (part of the R:BASE SQL facility). With either system, users can be granted various levels of access to all or part of a database.

Access to databases, tables in a database, data entry forms, and reports can be controlled with passwords and can be granted on a read-only or read-modify basis with the use of read and modify passwords. Passwords can be defined from Definition EXPRESS when the database is defined or modified, or with the DEFINE command, using the Read-Modify system. The SQL Grant-Revoke security system is accessed from the R> prompt.

Within a data-entry form, fields can be set as display-only. If the user is allowed to change the data in a field, the field characteristics can be set to allow or disallow changes to columns of the same name in other tables.

TRYING IT OUT

The *PC Tech Journal* editorial inventory application was implemented in R:BASE to test the package in a development setting. It is particularly demanding of application generators. Results of running the *PC Tech Journal* sample application is given in figure 1. (For a complete explanation of the sample application, see "Evaluating Data Managers as Development Tools," Julie Anderson, August 1985, p. 46.)

With Definition EXPRESS, the task of defining the sample application took less than 30 minutes. Once the database has been defined in R:BASE, forms, reports, and applications can be defined. The sequence is not critical, as the various EXPRESS modules provide full editing capability. All required reports and forms can then be incorporated into an application, or the developer can design a skeleton program and fill in the details later.

Reports and forms for the sample application were developed quickly and easily. The data-entry form for the Article file took approximately 20 minutes to write using Forms EXPRESS. Two reports with breakpoints took less than one hour to write with Reports EXPRESS. It was a simple matter to include the R:BASE mailing label utility in the application merely by adding a single line of code.

Defining menus and actions took the bulk of the time required to develop the application—approximately

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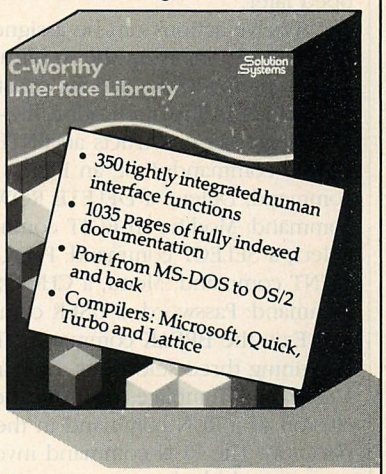

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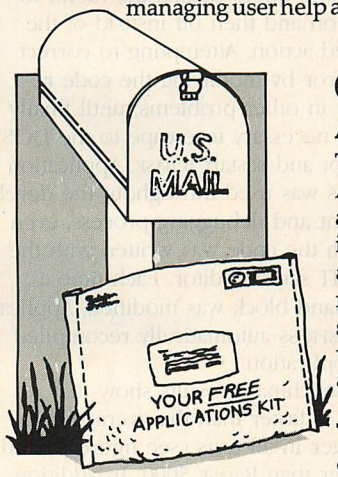

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four hours. Although Application EXPRESS was used to generate the application, it was necessary to write some R:BASE code and debug it because the application required command options not available from Application EXPRESS. For example, the application required queries that compute totals and averages of numeric fields. In timed benchmark tasks, commands to back up and pack the database were included immediately before the timed task.

Application EXPRESS proved to be an excellent tool for generating the overall application. It produces the code to display menus, accept user selections, and invoke the appropriate actions. In fact, Application EXPRESS can generate a shell program that invokes only stub routines, which can be developed later.

Twelve actions can be assigned to menu selections from the Application EXPRESS menu. These actions construct commands in the application file—selecting Load constructs an ENTER USING command; Edit, an EDIT USING command; Delete, a DELETE ROWS command; Modify, an EDIT command; Select, a SELECT command; Print, a PRINT command; Menu, a CHOOSE command; Password, a USER command; and Exit, the BREAK command. The remaining three selections, Custom, Macro, and Template, result in the inclusion of a RUN command in the application. The RUN command invokes a command block.

Although a combination of the actions, such as Load, Edit, Delete, Modify, Select, and Print, can be assigned to a menu selection, the resulting sequence of commands is linear in progression. Application EXPRESS uses While . . . Then . . . Endwhile and If . . . Then constructs to implement menus, but does not provide a method of building such constructs in menu actions, except when one menu selection displays another menu.

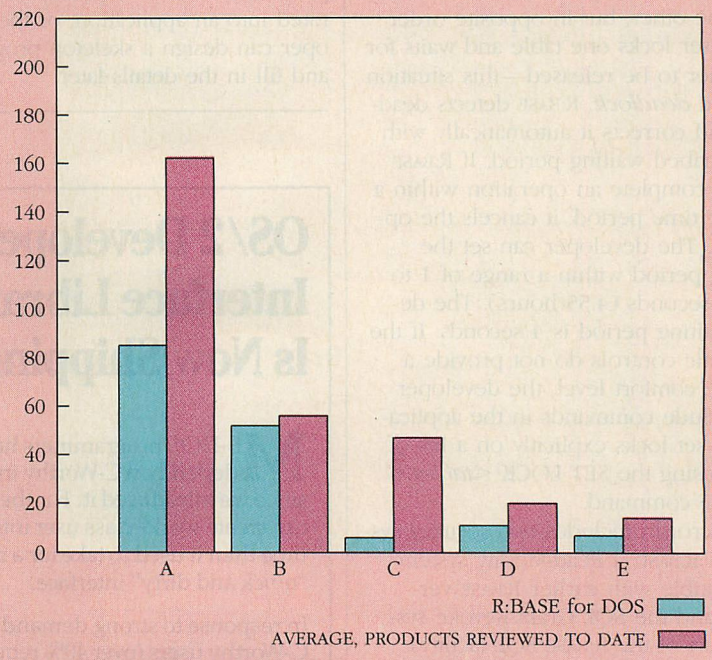
Thus, Application EXPRESS can not generate code for all tasks. A task such as changing the values of a field in a batch mode—one of the benchmark tasks developed for this data manager series—requires writing R:BASE code.

The code generated by Application EXPRESS to set up the environment and construct the menu system was flawless. Debugging was restricted to the small amount of code generated by the author and corrected errors such as omitting the ending quote marks for a prompt string. Omitting a quote caused a variety of unpredictable errors. In one case, selecting a menu option with a missing quote caused the menu to blink on and then off instead of the desired action. Attempting to correct the error by modifying the code resulted in other problems, until finally it was necessary to escape to the DOS prompt and restart R:BASE. Application EXPRESS was used throughout the development and debugging process, even though the code was written with the RBEDIT screen editor. Each time a command block was modified, Application EXPRESS automatically recompiled the application.

Benchmark results show that R:BASE is faster than the average data manager in all tests (see figure 3) and is faster than R:BASE 5000. In addition, if importing the author's file is done using the slower LOAD command rather than the faster file gateway mentioned here, the Developer's EXPRESS version runs 1.2 times faster than the CodeLock compiled version.

FIGURE 1: *Performance Benchmarks*

BENCHMARK TASK	TIME
A. Add 900 records to an empty database table	85
B. Index table on two fields (7 bytes)	52
C. Document and tally codes from one column	6
D. Mass change of one column (28 rows of 900)	11
E. Extract selected records to create a text file	7



All times are in seconds.

All benchmarks were run on an IBM PC/AT (6 MHz) with 640KB memory. The tests were run in an 8MB partition on a CMI 20MB hard disk under DOS 3.0.

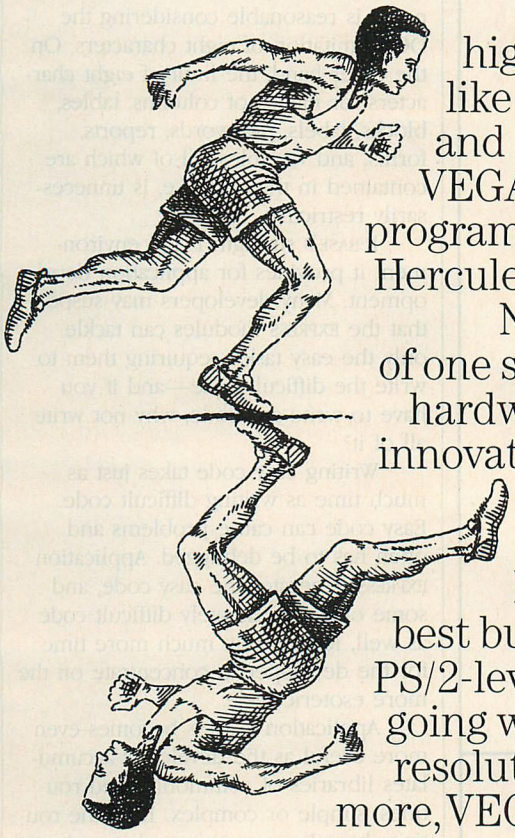
In all benchmark tasks, R:BASE for DOS performs better than average and slightly better than R:BASE 5000 (which was reviewed in September 1985).

POWERFUL ENVIRONMENT

R:BASE for DOS is clearly a powerful data manager. Although some systems allow more files and tables per database, the limit of 800 columns per database should be adequate for most applications. The limit of 4,096 bytes per row is comparable to record-size limits of other systems, and the file-size limitation is common to all DOS data managers. A system that uses a separate file for each table allows the database to be distributed across multiple physical or logical disk drives, theoretically allowing a larger database. However, if an R:BASE application requires a database larger than the standard DOS disk-drive partition, a disk-drive utility such as Golden Bow's Vdisk can remedy the situation.

The R:BASE language includes the essential data description, data manipulation, and general programming commands. The language does not include

How To Run Backwards & Forwards At The Same Time.



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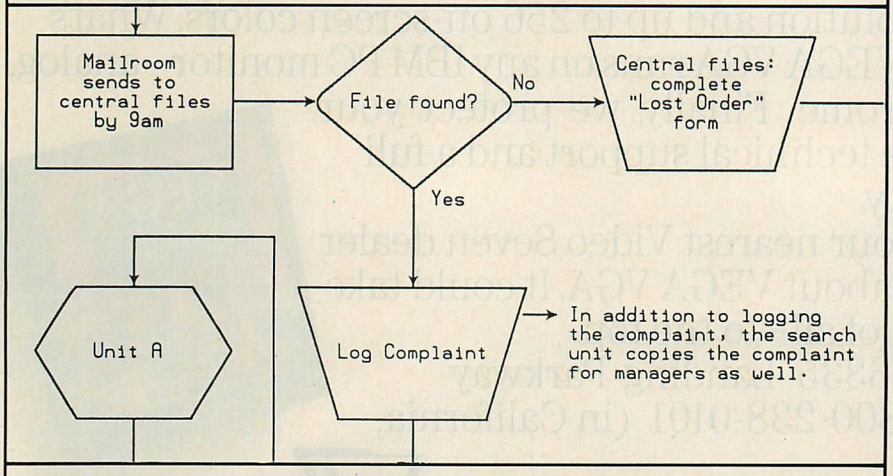

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R:BASE FOR DOS

a Case statement or a Repeat . . . Until statement, but the If . . . Then and While . . . Then . . . Endwhile statements can be used to the same end. Application EXPRESS constructs the equivalent of a Case statement with a series of If . . . Then statements. The Choose statement simplifies the task of displaying menus and storing the selection in a variable. The BREAK and GOTO <*label*> commands provide cure-all programming constructs.

R:BASE has some limitations that are inappropriate for a state-of-the-art data manager, as Microrim bills it. The limit of seven characters for a database name is reasonable considering the DOS limitation of eight characters. On the other hand, the limit of eight characters for names of columns, tables, blocks, labels, passwords, reports, forms, and variables, all of which are contained in the database, is unnecessarily restrictive.

R:BASE's strength is the environment it provides for application development. Many developers may suspect that the EXPRESS modules can tackle only the easy tasks, requiring them to write the difficult code—and if you have to write any code, why not write all of it?

Writing easy code takes just as much time as writing difficult code. Easy code can cause problems and often has to be debugged. Application EXPRESS generates the easy code, and some of the moderately difficult code as well, leaving that much more time for the developer to concentrate on the more esoteric code.

Application EXPRESS becomes even more useful as the developer accumulates libraries of commonly used routines, simple or complex. If all the routines have been written and stored on disk as command files, then generating an application by integrating these files is a simple matter.

R:BASE delivers everything Microrim promises—with one exception. The company claims that R:BASE reduces the knowledge required to develop applications and query databases, for both new and experienced users. Although R:BASE's PBE interface does indeed reduce the need to learn every command by rote, it does not take the place of a good understanding of database concepts. This understanding is still the key ingredient for effectively using any data manager, R:BASE included.

Victor E. Wright is manager of process engineering at Luckett & Farley, a firm located in Louisville, Kentucky.

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Sophisticated Expert

Texas Instruments' expert system shell, Personal Consultant Plus, offers considerable power, portability, graphics support, a reasonable price tag, and the backing of a major company.

SUSAN J. SHEPARD

With a moderate price ($2,950) and a reputation for developing commercially viable expert systems on the PC, Personal Consultant Plus (PC Plus) 3.02 from Texas Instruments (TI) offers high-end power to experienced expert system developers and less-complex options for novice developers and users.

This expert system shell stands out for its sophistication, versatility, and ease of use in a market where expert system shells for PCs are often rudimentary. PC Plus has been used to build and deliver complex commercial expert systems in areas as diverse as accounting, weld selection, machine diagnostics, grain marketing, and airline-gate scheduling.

PC Plus is built in Texas Instruments' implementation of the LISP dialect known as Scheme; however, developers do not need to know LISP to use PC Plus. Scheme is accessed through a LISP Edit facility to allow for custom programming.

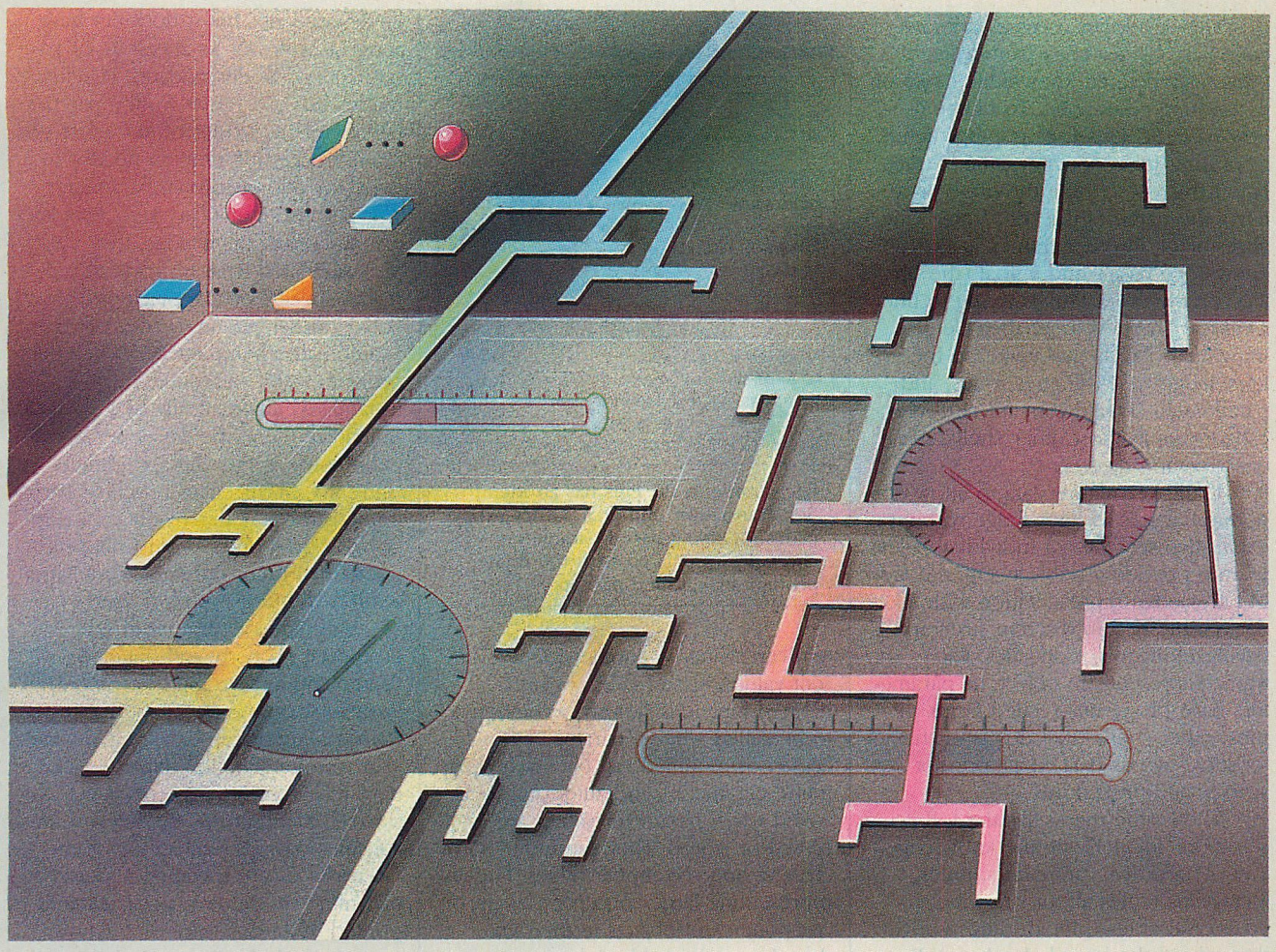
The expert system shell combines all of the minimum tools needed for building an expert system—data structures, inference engine, incremental development, tracing and debugging tools, confidence factors, a screen-oriented editor, and runtime system capability—with sophisticated features such as graphics, numerous interfaces to other programs, and combined data structuring. Customizing a natural-language interface can make an expert system developed with this shell particularly friendly to users.

One reason for its power is PC Plus's extended knowledge representation. It is frame-based but also can function as a rule-only system, which is helpful for novice developers. The combination is useful for complex problems where form and content of data are important and usually require both backward- and forward-chaining inferencing. This combined inferencing capability sets the product apart from other shells in the PC market (for a complete explanation of expert system shells, see "Computerized Reasoning," Tom Arcidiacono, May 1988, p. 44, and "Elements of Expert System Shells," Maxine Fontana and Jordene Zeimetz, same issue, p. 62).

Graphics support positions PC Plus well for industrial monitoring applications. Custom graphics can be programmed in Scheme, and static graphics screens can be added with the Snapshot facility, which works with several popular graphics editors (Media Cybernetics' Dr. HALO is recommended). The PC Images option package adds complex interactive graphics.

PC Plus produces commercial expert systems primarily for a PC delivery platform but with the option of delivering knowledge bases to Texas Instruments' Explorer LISP workstations or DEC VAX 11/780 machines. This kind of portability preserves investments in knowledge-base development if applications become too complex for a PC environment, perhaps due to thousands of rules or workstation-level graphics. PC Plus also allows development on the Explorer, taking advantage of its disk storage and memory and building efficient runtime applications for delivery to PCs.

Utilities are available for interfacing to dBASE II, III, and III PLUS and to Lotus 1-2-3; external DOS programs can be called from rules; and the product interfaces to C, Pascal, and assembly language. The shell's development



tools, modular design, levels of control strategies, and ability to prototype all aid in the early detection of an expert system's strengths and weaknesses and avoid expensive development mistakes.

The development interface features an enhanced window-oriented user interface. On-line help is available for the developer through pop-up windows and can be turned off during development to free memory. Developers are able to customize user help screens. An automatic documentation line is especially useful with rule screens because remarks can be attached to individual rules and displayed for quick reference when cursoring through a long list of rules.

PC Plus operates on the following systems: TI Business-Pro Professional Computer, IBM PC/AT or compatible, Compaq Deskpro 386 or compatible, and IBM PS/2 Models 50, 60, and 80. The operating system can be DOS 2.1 or later; the product requires and ships with PC Scheme 3.02 and supports a Microsoft Mouse or compatible. PC Plus also requires graphics support (EGA is recommended), a hard-disk drive with 1.5MB of memory available, and 640KB of RAM (2MB expanded or extended memory is recommended).

With the additional memory, the system performs well. At 640KB, out-of-memory errors are common and using add-on boards is virtually impossible. For DOS-based applications in extended memory, pressing the F4 key causes a compacted garbage collection that yields speedy performance despite memory management overhead. When enhanced memory is used, problems can arise if the Lotus/Intel/Microsoft expanded memory specification (EMS) driver is not configured properly or if it is out of date. With a properly installed driver, PC Plus performs well in 2MB of expanded memory.

The runtime version can use the same operating systems and computers as the regular version, as well as PCs and compatibles, PC/XTs and compatibles, and TI Professional computers. It also can be delivered in LISP or C. The runtime version requires at minimum 640KB of RAM as well as two 360KB diskette drives. Additional requirements, such as a hard-disk drive, depend on the size of the knowledge base and graphics screens.

REPRESENTING KNOWLEDGE

PC Plus's knowledge representation method combines data structures (for storing information and procedures) used to make inferences and draw conclusions. It combines powerful *frames* (structures containing data and procedures that are arranged in a tree) with *rules* (If . . . then statements) that can be ordered and optimized. The PC Plus knowledge representation method also supports simpler rule-only systems that the developer can build by defining only one frame.

The frames and rules combination yields several efficiencies over a rule-only system: relationships are stored along with data; attribute values are stored only once and at the highest level at which the attribute applies, reducing memory storage requirements; and values can be evaluated using either procedures or rules, so the developer can incorporate both in the system's design. Frames are particularly powerful for dealing with incomplete, uncertain, or missing data because frame parameters provide a place for data obtained from the user or through inferencing.

ILLUSTRATION • ANDY LEVINE

The developer accesses a knowledge base by selecting from a list of previously defined knowledge bases or by creating a new one. To define a new base, PC Plus uses pop-up menus to prompt for a domain name, a translation (text describing the expert system), the name of the root frame (the ancestor of all other frames in the knowledge base), and a goal (the object for which PC Plus is trying to find a value). The developer then defines individual objects that make up the knowledge base—frames, rules, and parameters. (Parameters are attributes, called slots in most other shells, that describe an object).

Frames structure data to allow economical access to knowledge without exhaustive searches of individual rules. Frames provide an object-centered view of knowledge representation with all data partitioned in discrete structures having individual properties. Each frame represents an object; its parameters have properties (called facets in most other shells) that describe characteristics such as data types, prompt strings, and procedures.

The Frame menu has the following selections for defining the knowledge base: Properties, Parameters, Rules, Meta-rules (rules about rules and goals), Variables (global values known throughout the knowledge base), Functions (executable procedures) and Textags (names that call up specific text).

Frame properties. Frame properties include Goals, which specify the parameter whose value is being sought; Meta-rules, which list meta-rules associated with the frame; and Rulegroups and Parmgroups, which identify groups of rules or parameters associated with the frame and lists them. The developer also can specify several prompt and explanation strings.

Rule groups and meta-rules within a frame can increase both the development and execution efficiency of the delivered expert system. For example, in the Diesel Engine Troubleshooter (a sample application developed with PC Plus for this review), all rules for the fuel system are in groups associated with the fuel frame, so that any developer who is fine-tuning or modifying the system knows where to find them (see figure 1). Execution of the final system can be accelerated because a rule group is not examined unless the frame with which it is associated is accessed.

If an expected event does not occur (for example, a rule fails or a value cannot be found), then the system can switch to another frame. Current values, sets of rules, or user-defined functions (known as *demons*) to be called when a parameter is accessed or modified can be attached to frame parameters and automatically invoked when parameter values are accessed or stored. They can monitor changes and recompute values. Frames, representing large concepts, classes, or components of objects in the same domain, are joined by inheritance.

FIGURE 1: ***Fuel Frame***

```
====================
Frame :: FUEL
====================

IDENTIFIER :: FUEL-
TRANSLATION :: (the probable solution for the
               fuel system problem)
PARENTS :: (ENGINE)
GOALS :: (FUEL_SOLUTION)
PROMPT1ST :: (premise)
PREMISE :: ($AND
          (SAME FRAME STARTS))
PARMGROUP :: FUEL-PARMS
RULEGROUPS :: (FUEL-RULES)
FUEL-PARMS  :: (AIR_TEMP FUEL_SOLUTION
               STALLS WATER)
FUEL-RULES  :: (RULE002 RULE004 RULE005 RULE006)
```

Each frame in PC Plus has an identifier, translation, and goal. Other properties include a list of parameters and rules associated with the frame, prompt strings, and parents.

The inheritance structure of PC Plus is a frame tree, consisting of a root frame and one or more subframes (see figure 2). A subframe's ancestors are all the frames in a direct line from the subframe to the root frame. The immediately preceding frame is its parent frame; frames succeeding it in a direct line are child frames, which are not limited in number.

Inheritance among frames increases programming efficiency, and it simplifies programming because some relationships are implicit rather than entered in rules. Inheritance allows an application to pass data, rather than requesting it again from the user or recomputing it. Inheritance need not be automatic, however; it can be blocked by writing rules to bypass the tree hierarchy when obtaining data.

After defining the root frame, the user adds subframes and then structures them into the tree by cursoring to the parent, pressing the F2 key to pop up the Commands menu, and selecting Add. Selecting Tree On from the pop-up menu displays the hierarchy on the screen.

Each subframe inherits the parameters of its ancestors and the rules of its descendants, but it does not have access to rules of its ancestors or parameters of its descendants. PC Plus frames can use values from a parent's parameters and rules of one of its subframes to get information needed as a value for one of its own parameters.

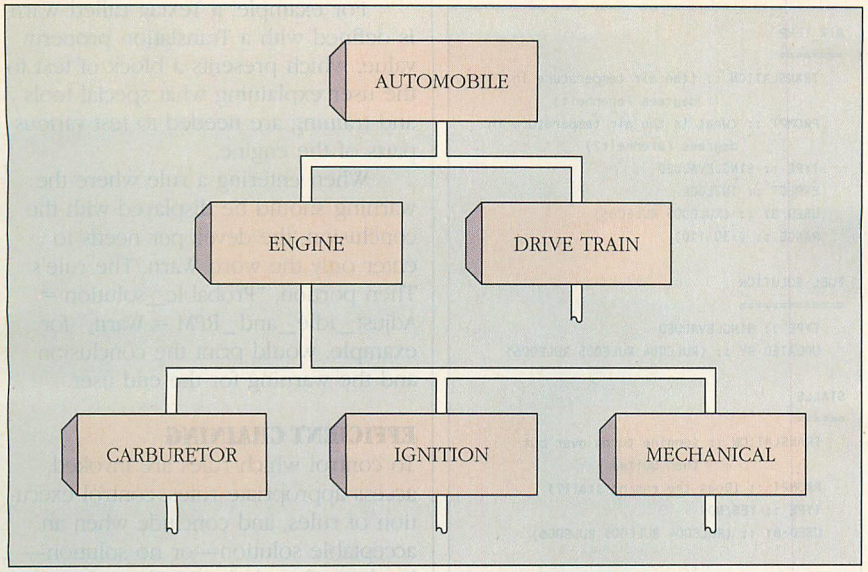
Because frames are only templates for structuring knowledge, they must be instantiated (that is, made to represent specific objects, such as a Volvo_diesel_engine). The root frame is automatically instantiated when the program starts. Subframes are not instantiated automatically by PC Plus; to instantiate them, the developer must build controls into the application using the Occurrences property. Each frame can occur Exactly-once, At-least-once, At-most-once, or an Unknown number of times during a consultation session with the expert system.

Subframes have a required Prompt1st property and optional Prompt2nd and Promptever properties. Prompt1st can be a prompt that requires a yes/no response to allow the user to instantiate the frame, or it can have the Premise property (new to version 3), which allows the logic of the consultation to instantiate the frame. If Occurrences are specified At-most-once or Unknown, the Prompt1st string is printed. If At-least-once or Unknown are specified, the Prompt2nd string is printed for all instances of the frame after the first. If Exactly-once or At-least-once are specified, the Promptever text is printed whenever this frame is instantiated.

Because Premise directs PC Plus to instantiate a frame only when a specified condition is met, it is useful if the Occurrence property is At-least-once or Unknown. Premise can be combined with user-controlled instantiation by making the Prompt1st value a yes or no choice and automating subsequent instantiations using Premise in the Prompt2nd property. The Premise property is added to the frame's properties list with the clause that expresses the conditions that must be found true for instantiation.

Parameter properties. For each parameter, the developer must assign properties (see figure 3). These parameter properties include Name, Type (the value PC Plus can expect for that parameter, such as Single-valued or Multi-valued), and Translation (an explanation string). Other properties of parameters include: Active-value (action to occur when the parameter is given a value); Certainty-factor-range (certainty to be entered when responding to a

FIGURE 2: *Automatic Problem Diagnosis Tree*



PC Plus uses a tree structure to control inheritance. Each leaf frame inherits all parameters and properties from every other frame in its ancestral line.

prompt), Default (value assumed for a parameter when no other is given); Prompt (prompt for a parameter value); Expect (list of possible values); Range (acceptable bounds for numeric values); and Method (user-defined function or external call to dBASE or Lotus, for example). PC Plus prompts for associated properties if necessary. For example, if the type is Ask-all or Single valued, then the Prompt and Expect properties must be specified.

PC Plus system properties record how and when a frame uses each parameter. For example, Updated-by lists consequent rules that conclude a value for the parameter and Used-by lists consequent rules that reference the parameter in If and Then clauses. Values can be assigned to parameters by the user responding to a prompt, a rule concluding a value, a method (a PC Plus or user-defined function to be called as a first attempt at finding a value for a parameter), or a default.

The developer can view parameters by selecting the Parms option from the Frames screen. At the ParmGroup screen, parameters are added, renamed, moved, or erased by pressing F2 to access the Commands menu or by using Alt-*X*, where *X* is the first letter of the action to be performed.

Rules. In PC Plus, rules are part of the frame structure (see figure 4 for rules in the Fuel frame). Rules can be written in either LISP or PC Plus's English-like rule-entry language, Abbreviated Rule Language (ARL). In order to enter rules with ARL, the user accesses the menu by selecting the Rules option from the Frame screen. Pressing the F2 key provides a pop-up menu for adding, erasing, and moving rules. The Add option causes PC Plus to prompt for If (antecedent) and Then (consequent) clauses.

If a frame is large and has many rules, it can be divided into rule groups that are shared by several frames. Rule properties include Antecedent, which means the rules will be used in forward chaining (the default is consequent rules, used in backward chaining); Description, which provides a text line for the rule group; Dobefore, which lists rules PC Plus should try before the current one; Explanation, which answers how and why questions; Utilities, which assigns priorities to rules; and User-defined, which documents the rule.

Meta-level knowledge. Meta-level knowledge improves the performance of expert systems by allowing the knowledge base to learn from experience which rules are most useful, causing the system to try the most useful ones first, and reordering the way rules are tried or goals are searched, based on new information from inferencing or user input.

PC Plus offers meta-knowledge by Meta-rules and by its Utility and Dobefore properties, which can be specified for both rule and goal parameters. Meta-knowledge is a powerful feature of PC Plus because it allows the developer to participate in fine-tuning inference strategies.

The developer enters Meta-rules from the root frame Activities menu. They work with the Dobefore rule property, which lists rules to try before the current one; the Utility rule property, which ranks rules by usefulness; and the Utility parameter property, which assigns priorities to goal parameters. Utility values range from −100 to +100, with a default value of 0. If several rules are applied or several goals searched, PC Plus tries the one with the highest Utility value first.

For each parameter whose value is set by a rule, PC Plus maintains a system property called Updated-by, which lists all rules assigning a value to that parameter. Rules are listed in priority by Utility value or, if the values are the same, in the order they were entered or modified. Because this might not be the most efficient order to apply rules, Meta-rules can reorder or shorten the list by modifying the Utility and Dobefore rule properties.

When assigning a value to a parameter, the inference engine applies all Meta-rules associated with the parameter and then alters the Updated-by list by placing highest-priority rules first. If several goals are to be solved, Meta-rules again are applied to prioritize the search.

In the Diesel Engine Troubleshooter sample application, two rules exist about two different automobile models. One rule states that if the engine does not turn over and the model is Volvo, then a high probability exists that the problem is water in the fuel. A second rule states that if the engine does not turn over, then a medium probability exists that the problem is water in the fuel.

If both rules have the same Utility value and the developer wants the rule that traces the automobile model parameter to be tried first, the second rule is given a Dobefore property with the first rule as a value. The developer could write a Meta-rule to alter the Dobefore list based on information gathered by inferencing. For example, the following Meta-rule algorithm could be applied:

IF the engine does not start
AND there are rules that mention in their premise electrical system failures
AND there are rules that mention in their premise fuel system failures
THEN the former should be tried before the latter.

The developer can assign highest Utility values to rules that are likely to be most useful. If this is not clear, the

developer can write a rule to trace rules fired most often and increase their Utility values automatically.

Variables. Like parameters, variables are a form for data storage, but they are not restricted by frame inheritance. Variables are declared only from the root frame and can include information that must be known to the entire knowledge base, not to just one frame or branch of the inheritance tree.

Variables are most productively used in comparison statements in the antecedent of a rule, in assignment statements in the consequent of a rule, in messages that direct a consultation, and in Expect properties when several parameters expect the same values (to avoid entering the same list of values redundantly).

Functions. Using the Functions option, developers define functions for custom operations. PC Scheme is used to write these functions, which might be iterative calculations, display graphs, or any routine that customizes the application. Functions can be written for many knowledge-base elements, such as a rule's If or Then clauses.

Textags. Textags are useful for communicating with the user. In portions of the Diesel Engine Troubleshooter sample application, rules about testing compression and similar activities require special tools and training.

For example, a Textag called Warn is defined with a Translation property value, which presents a block of text to the user explaining what special tools and training are needed to test various parts of the engine.

When entering a rule where the warning should be displayed with the conclusion, the developer needs to enter only the word Warn. The rule's Then portion, "Probable_solution = Adjust_idle_and_RPM = Warn," for example, would print the conclusion and the warning for the end user.

FIGURE 3: *Properties*

```
AIR_TEMP
========
   TRANSLATION :: (the air temperature in
                   degrees Farenheit)
   PROMPT :: (What is the air temperature in
             degrees Farenheit?)
   TYPE :: SINGLEVALUED
   EXPECT :: INTEGER
   USED-BY :: (RULE005 RULE006)
   RANGE :: (-30 110)

FUEL-SOLUTION
=============
   TYPE :: SINGLEVALUED
   UPDATED-BY :: (RULE004 RULE005 RULE006)

STALLS
======
   TRANSLATION :: (engine turns over but
                   then quits)
   PROMPT :: (Does the engine stall?)
   TYPE :: YES/NO
   USED-BY :: (RULE004 RULE005 RULE006)

WATER
=====
   TRANSLATION :: (water in the diesel fuel)
   PROMPT :: (Can water be drained from the
             fuel_filter drain cock?)
   TYPE :: YES/NO
   USED-BY :: (RULE005 RULE006)
   TYPE :: YES/NO
```

Parameters are described further by properties such as prompt strings, data type, type of value expected, and list of rules using the parameter.

EFFICIENT CHAINING

To control which rules are invoked, access appropriate rules, control execution of rules, and conclude when an acceptable solution—or no solution—has been found, the PC Plus inference engine uses backward chaining (searching consequents of rules to find a pattern that matches the goal pattern) as its primary (and default) problem-solving strategy.

Backward chaining—goal-driven inferencing—is efficient because the system waits until an answer is needed before trying to infer it. It is most useful in problems where a possible goal

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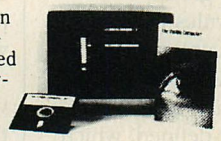

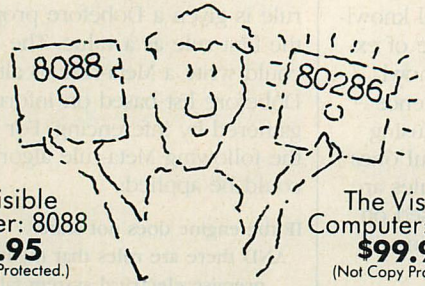

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can be identified and when information for inferencing is acquired from the user or from a source outside the knowledge base.

Backward chaining moves from the current goal backward in a depth-first search of rules to prove or disprove the current goal parameter. First, all rules that have the goal in their consequent clause are found and their conclusions ranked by certainty factors. The certainty of a rule's action is based on the certainty factors of the parameters in both its antecedent and its consequent. The inference engine examines the antecedent of each rule ranked by certainty, looking for antecedents that are true. When antecedent conditions are met, the rule fires (that is, the actions in the consequent clause are carried out).

If values for parameters in a rule premise are needed, then the parameters become subgoals; the inference engine searches for rules that conclude values for the subgoals. The result is a system with a focused, methodical approach to problem solving, which is a definite advantage for the developer.

PC Plus also supports forward chaining, which is data-driven. The inference engine moves from known facts forward to a goal that is unspecified when the process starts. Forward chaining is useful when all knowledge is already available to the system, and the system works forward from that data. The developer specifies forward chaining by assigning the Antecedent property to rules; PC Plus tests an antecedent rule when it has assigned a value to one of the parameters in the rule's If statement.

Antecedent rules serve many purposes in PC Plus. For example, they quickly provide a value for a goal if the facts in the If clause are known; avoid prompting for a large number of parameters for which the response is unknown or is not relevant at the time; and invoke a rule that does not conclude a value for a parameter but only displays text to the user.

IDEAL TROUBLESHOOTER

The sample troubleshooter application for diesel automobile engine problems is the type of diagnostic work for which backward chaining is ideally suited. PC Plus breaks the goal into subgoals and works backward to see if antecedents in the rule base satisfy the goal and attempts to determine the likelihood that each rule is true.

PC Plus 3.*x* is more powerful than version 2 in the areas of prototyping, development, and delivery. In this review, some examples from a working expert system developed in PC Plus 2.0 and enhanced in version 3.*x* illustrate development. Knowledge bases almost always can be moved up to the new version with no changes; some revision may be necessary to take advantage of extended development commands, frame properties, and rule language. In addition, interactive graphics can be added easily with the new PC Images add-on package.

Frames make the troubleshooter easy to build and maintain because various subproblems about diesel engines—the fuel system, the electrical system, the lubrication, the mechanics of drive belts and accelerator cables—are readily expressed as subframes. For example, Fuel subframes embody knowledge about the fuel system, and Electrical subframes encompass information about the ignition system.

Developing the sample system from scratch reveals just how easy PC Plus is to use. The system is called with a batch file, checks for expanded or extended memory, then loads the appropriate configuration of PC Scheme. Loading Scheme, even on a 16-MHz 80386-based system with a fast hard disk, takes less than one minute. Loading and running PC Plus is relatively fast by both expert system and microcomputer LISP standards.

FIGURE 4: *Fuel Rules*

```
RULE002
=======
   SUBJECT :: FUEL-RULES
   IF   :: (STARTS IS DEFIS)
   THEN :: (PROBABLE_SOLUTION = FUEL_SOLUTION
           CF 50)
RULE004
=======
   SUBJECT :: FUEL-RULES
   IF   :: (STALLS)
   THEN :: (FUEL_SOLUTION = FUEL_FILTER CF 50)
RULE005
=======
   SUBJECT :: FUEL-RULES
   IF   :: (STALLS AND WATER AIR_TEMP > 32)
   THEN :: (FUEL_SOLUTION = FUEL_FILTER
           AND PRINT "Drain the water from the
           fuel filter and close drain cock.:)
RULE006
=======
   SUBJECT :: FUEL-RULES
   IF   :: (STALLS AND WATER AIR_TEMP < 32)
   THEN :: (FUEL_SOLUTION = COLD AND PRINT
           "Plug in the block heater if there
           is one or move the car to a
           warm garage.")
```

These rules can be used to solve an engine problem caused by fuel-system failure. Rules 2 and 4 have an assigned certainty factor of 50 percent.

Development begins by creating a knowledge base titled Diesel Engine Troubleshooter. The root frame, Engine, is defined; root frame information needs to be entered only once, but can be edited anytime.

A Translation property value for Engine is then entered to provide text describing the frame's purpose. PC Plus uses the Translation value when it translates rules into explanation strings; constructs the prompt; creates Promptever text for the root frame; provides a default translation for the Goal parameter; and refers to the frame in response to a How, Why, or Review command.

In the sample application, the Translation property value is "the probable cause and solution of the engine problem." PC Plus inserts this value into English-text messages. Although not strictly required, all frames and parameters should have a Translation property value, even if only for developer reference.

The root frame needs a goal or problem to solve. For the Diesel Engine Troubleshooter, Probable_solution is the only goal. The user enters it in the window by typing the goal name. The system then solves the problem by providing a value for the goal or issues a message that a value cannot be found.

PC Plus does not proceed unless each parameter has a type, which determines how the system traces the parameter and how it builds prompt screens. The developer is prompted with a menu of available types: Yes/no, Single-valued, Multi-valued, Ask-all. If the developer chooses the Yes/no type for a parameter, then the user can enter only a yes or no answer.

Single-valued means that the parameter can have one value with absolute certainty or multiple values with less-than-absolute certainty. The Probable_solution parameter is Single-valued because it might conclude with a value of Warm_car 50 percent and Drain_fuel_filter 50 percent or with a value of Replace_glow_plugs 100 percent.

A Multi-valued parameter could have multiple values, each with absolute certainty. Ask-all is the same as Multi-valued except that the developer is prompted to enter an Expect property that lists all possible responses from which the user selects. PC Plus repeats this procedure for each parameter.

Once the root frame is described, the developer selects the Develop command to provide a menu of available

frames in this domain. In the diesel engine example, Engine is the only frame defined so far. Properties, parameters (Engine-parms), rule groups (Engine-rules), Meta-rules, Functions, and Textags can now be defined.

ARL defines rules for the Diesel Engine Troubleshooter. At the Rulegroups screen, rules can be entered using the pop-up command menu or the Alt-A key combination. A window opens and the developer types in the If premise using ARL (the system presumes the word "If"). A simple starting rule, which places the parameter Starts in the antecedent, is:

```
STARTS IS DEFNOT
```

Pressing the Enter key forces PC Plus to check the premise for semantic errors before opening the Then window. The consequent, which includes a certainty factor of 50 percent is:

```
PROBABLE_SOLUTION = ELECTRICAL
                    CF 50.
```

Because Starts is a new parameter, the Translation property value, "the engine does turn over," is entered. PC Plus takes care of inserting "not" in the translation if a consultation concludes that the engine does not, in fact, turn over. The end user must supply the system with this information by entering a Prompt value in the prompt window. The prompt, "Does the engine turn over at all?", elicits the needed information for this rule from the user—the engine either definitely starts or definitely does not.

Later rules are tried as needed to refine knowledge, by querying the user or by inferencing, and to determine if the problem is in the battery, starter, or fuel system.

If a programming error exists, PC Plus states the nature of the error and gives the option of editing the offending clause. If the edit is not correct, the flag is repeated until the rule is acceptable; on-line help and the *PC Plus Reference Guide* are sometimes useful in debugging rules. If the developer chooses not to edit, the system marks the rule invalid and gives the reason. Invalid rules are not tried.

When a rule is on the screen in ARL, as in the following:

```
IF::STARTS IS DEFNOT
THEN::PROBABLE_SOLUTION =
  ELECTRICAL CF 50
```

either Alt-T or the pop-up menu reports on the system's understanding of this rule in English, based on the Translation property entered:

IF it is definite that the engine does not turn over,
THEN there is suggestive evidence (50 percent) that the probable solution is electrical.

The rule and its properties can be changed using the Modify command if the translation, or the system's performance, proves that the conclusion is not what the developer intended. Selecting Modify invokes the screen editor and presents the rule clause for editing.

If the developer forgets some parameters, pressing Alt-P brings up a window that lists them. Parameters also can be copied into rules from this window. The Add and Erase selections at each rule window allow adding or subtracting rule properties such as Description, which is a cue line appearing on the screen's document line that reminds the developer of the rule's purpose.

PC Plus offers many rule utilities that reduce developer error and make the system easy to use. For example,

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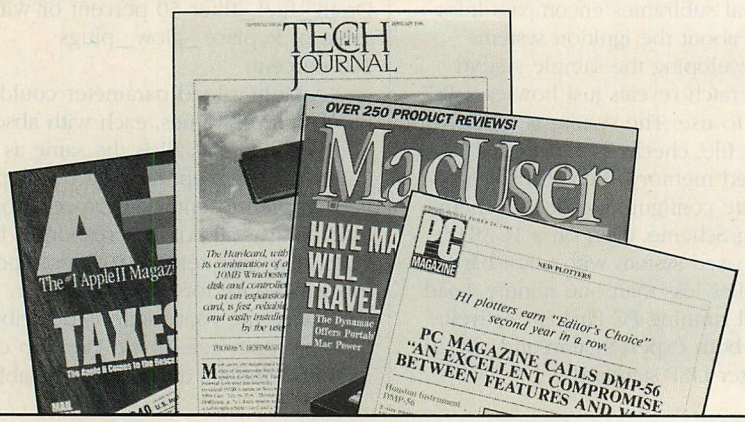

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when Add is requested, a pop-up window lists the properties the given rule does not already have so that the developer can select one to add. A help line at the bottom of the screen reminds the user of the property functions. For example, if the Dobefore property is chosen from the Add property menu, the cursor is placed on that name and a window opens to accept the rule or rules that the system should try before the current rule.

The Copy command shortens development time and reduces errors. It copies an If or Then clause from an existing rule into a new rule being created by entering the rule number. If only a percentage of the If clause is used in the new rule, the clause can be copied and then edited.

Subframes are entered from the Frames menu with the mnemonic Alt-key or pop-up menu. The cursor first is placed on the parent frame; frames can be moved later if an error or change is made. Prompts are the same as for the root frame except that the developer can assume much more control.

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The developer is prompted for the Occurrence property. For the Fuel subframe, an Occurrence of At-most-once is selected because the Fuel frame might not need to be instantiated at all during a consultation if, for example, the Probable_solution goal is satisfied before the rule group attached to the Fuel frame is tried. If Exactly-once or At-least-once are chosen, the system instantiates the frame whether or not it needs to. Occurrence can be edited during development; the developer is prompted for other changes that might be needed as a result of an Occurrence change. This makes it possible to experiment without risk.

Upgrading the diesel engine system to use the Premise property improves performance and smooths the consultation by allowing the logic of a consultation to determine frame instantiation. The property list for the subframe Fuel includes Premise, which causes the frame to be instantiated if the diesel engine starts.

During development, test consultations can be conducted with even a rudimentary knowledge base. When the full-scale Diesel Troubleshooter system was being built, each test consultation resulted in either identifying an error or verifying correct performance of the system to that point. One of the assets of expert system development over conventional software development is that the expert system testing and expanding process does not stop. PC Plus continues to support ongoing testing and expansion.

FINE-TUNING AND DEBUGGING

PC Plus is an excellent prototyping environment because it supports modular development and offers complete error trapping, tracing, debugging, and validation tools. Its straightforward explanation feature informs users why and how the system reaches a conclusion and which rules it uses. This helps identify incorrect rules and is valuable for developing and debugging an application, especially when the human expert is asked to verify conclusions.

Optional facilities new to PC Plus 3.x for debugging include Browse, which permits the often complex interrelationships among rules to be viewed with an easy-to-follow display. Available at the Frames menu, Browse allows the developer to choose a single parameter and see a visual display of its relationship to rules and other parameters.

Another optional facility is Trace On, which generates a text record of the flow of logic. The record can be

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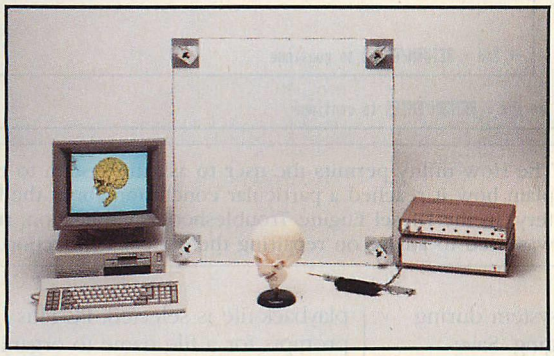

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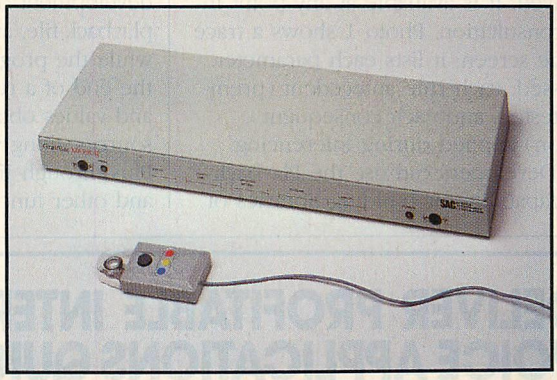

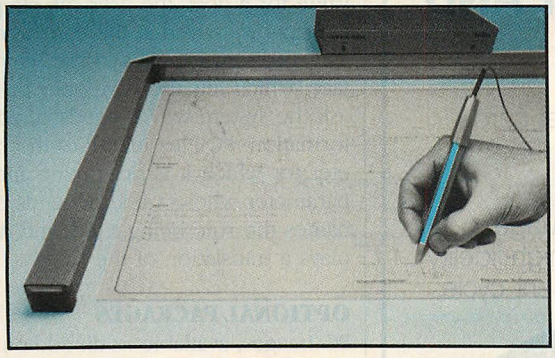

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PHOTO 1: *Trace On Utility*

```
-                    Diesel Engine Troubleshooter

=== USER ENTRY === :  ENGINE-1 STARTS  =  (YES 100)
Setting parameter   :  ENGINE-1 STARTS  =  YES  cf 100
End tracing parameter: ENGINE-1 STARTS
Rule premise fails  :  ENGINE-1 RULE003
Testing rule premise:  ENGINE-1 RULE001
Apply action        :  ENGINE-1 RULE001 TALLY 100
Setting parameter   :  ENGINE-1 PROBABLE_SOLUTION  =  FUEL_SOLUTION  cf 50
Completed action    :  ENGINE-1 RULE001
Suspending rule     :  RULE002  for subframe creation.
Testing frame premise: FUEL

Frame  FUEL-1  created  under  ENGINE-1
Trace the following goals :  FUEL_SOLUTION
Tracing parameter   :  FUEL-1 FUEL_SOLUTION
Try the rules that deduce  FUEL-1 FUEL_SOLUTION  :  RULE004 RULE005 RULE006
Testing rule premise :  FUEL-1 RULE004
Tracing parameter   :  FUEL-1 STALLS


 ** End - RETURN/ENTER to continue
```

If the user specifies Trace On, all steps in the inference process are printed on the screen or output to a file. This is extremely useful for the developer in debugging and for the user in understanding why a conclusion is reached.

PHOTO 2: *How Utility*

```
-                    Diesel Engine Troubleshooter

Clean the terminal posts and cables.  Be sure they are firmly connected.

 ELECTRICAL_SOLUTION :: (CLEAN_AND_TIGHTEN 100 RULE009)

 Determined to be:  CLEAN_AND_TIGHTEN
  ... by using  RULE009

 If   cables from the battery to the electrical system,
 Then 1) it is definite (100%) that ELECTRICAL_SOLUTION is
         CLEAN_AND_TIGHTEN, and
      2) inform the user of this decision.




  ** End - RETURN/ENTER to continue

** End - RETURN/ENTER to continue
```

The How utility permits the user to ask the system to explain how it reached a particular conclusion about the battery. In the Diesel Engine Troubleshooter application, rule 9 was used to advise on repairing the battery connection.

written to the screen, sent to a printer, or saved. It is available at any point in the consultation. Photo 1 shows a trace on the screen; it lists each parameter accessed, each rule antecedent (premise) tested, and each consequent (action) applied during inferencing.

Developers can use the Playback-file capability for building libraries of consultations with the system during development or debugging. Save-playback-file, available from any prompt while the program is running and at the end of a run, stores user responses and values obtained from external sources along with data obtained by PC Plus through Import, Read-from-file, and other functions. When Save-playback-file is selected, PC Plus prompts for a file name to organize the consultation library. Get-playback-file retrieves the record so the consultation can be rerun.

The developer can establish procedures to allow the user to question the system's results using the How debugging and verification tool. With How, the user can ask what information led to a result, which rules were tried and which were fired, and what logic was used to make a conclusion (see photo 2). If a system returns an incorrect value for a goal, the user can simply ask how it arrived at the conclusion.

The same applies to the Why interface, which lets the developer or user ask the system why it needs certain information. PC Plus identifies the parameter for which it is prompting and the parameter whose value depends on it, names the rule being tried, and displays a translation of the rule.

OPTIONAL PACKAGES

PC Images, available as an add-on for $495, permits complex interactive graphics to be incorporated into run-time knowledge-based applications. Graphics help familiarize users with a process or piece of equipment.

With PC Images, developers can create sophisticated user interfaces or address problems such as process monitoring or data interpretation. The package is installed on PC Plus and then selected from the regular PC Plus activities menu. It is menu-driven (see photo 3), supports EGA graphics, and ships with its own manual and quick-reference pages.

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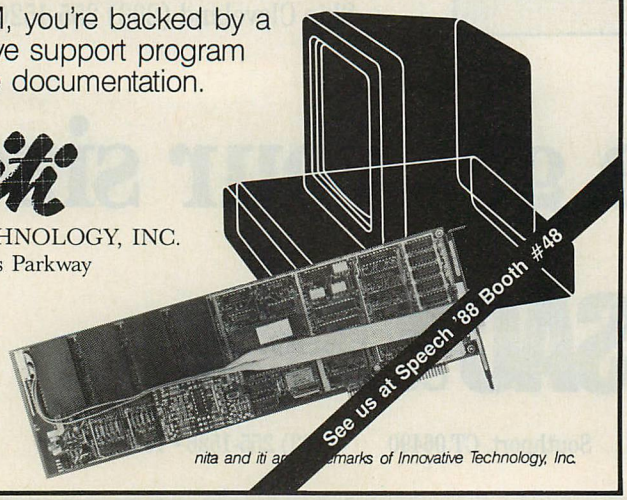

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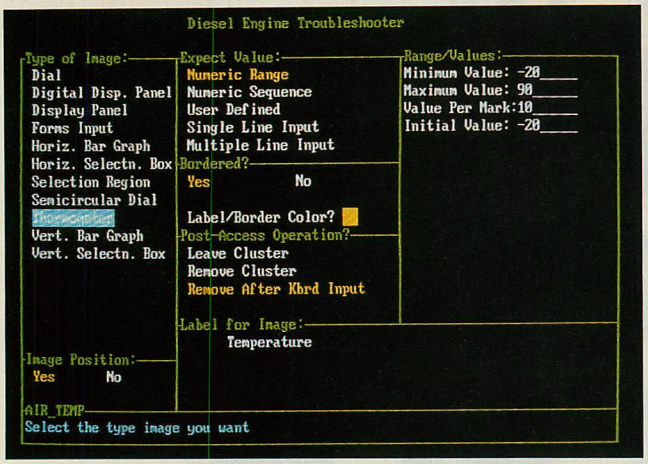
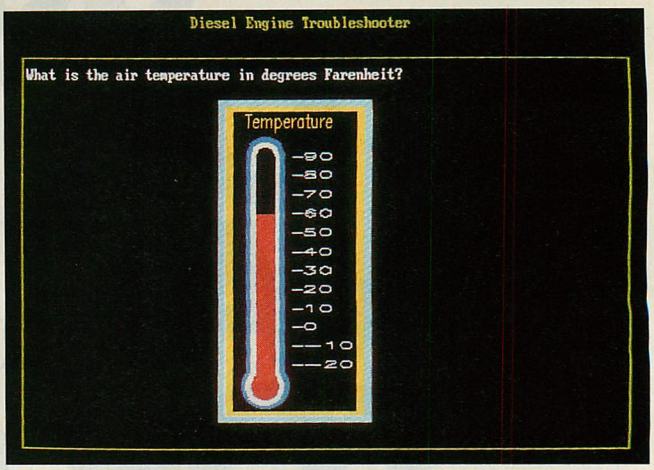
PHOTO 3: *PC Images Menu*



PC Images adds graphics images to the expert system. Its menu lists available predrawn images and selections for screen formatting and specifying the value type and range.

PHOTO 4: *Image from Troubleshooter*



PC Images provides a thermometer image to help the user designate the current temperature. The user selects a temperature by pressing the up and down arrow keys.

Developers can use Dr. HALO and other third-party graphics packages to create interactive input forms in which users simply fill in the blanks for processing, and to produce and incorporate images of complex machinery or elaborate processes.

Photo 4 shows a simple thermometer display produced by PC Images for the Diesel Engine Troubleshooter. PC Images also can display multiple images on the screen simultaneously to represent clusters of output instrumentation or multiple input formats. A single screen might include output gauges and dials, forms with input regions, selection boxes, and portions of predefined graphics created with PC Plus's Snapshot facility and a third-party graphics editor.

Developers also can use third-party graphics packages, such as Dr. HALO, to create interactive input forms in which users simply fill in the blanks for processing and to produce and incorporate images of complex machinery or elaborate processes.

Another add-on package, called PC Online, allows PC Plus to interact directly with processes, such as industrial monitoring, without requiring extensive human interaction. PC Online can also be used for intelligent batch processing and remote input and consultation.

POSITIVE REINFORCEMENT

PC Plus documentation includes the *PC Scheme User's Guide*, *TI Scheme Language Reference Manual*, *PC Plus Reference Guide*, and *PC Plus Getting Started* (an overview and tutorial). The documentation is packed with examples, and the information is well indexed, easy to find, and easy to understand; however, it is lacking in theoretical depth.

An overview chapter describing advantages of different knowledge structures and how the inference engine works would be useful to help developers design the optimal expert system. Novice expert system developers will know what to do from looking at the documentation; however, they will have to seek outside references to know why.

The documentation uses some terminology unique to Texas Instruments and does not explain how the terms relate to terms used in most other shells. For example, PC Plus uses the term parameters instead of slots, and properties instead of facets.

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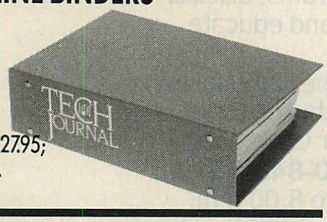

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PC Plus is an all-purpose development tool for expert systems for the PC. Its advantages include portability to LISP machines and to minicomputer and mainframe environments; frame- and rule-based power; forward- and backward-chaining inferencing; high-end features; compatibility with a variety of installed PCs; numerous interfaces to other programs; LISP origins; unusually advanced graphics support; association with a major company; and ease of use for users and developers.

Other pluses are that rules can be grouped with frames to ease organization and maintenance of the knowledge base; and developers can have input into the order of inferencing using Meta-rules and the Dobefore and Utility properties.

Features that could strengthen PC Plus are more theoretical depth in the documentation for beginners, the ability to use examples to learn by induction, and large-system features such as hypothetical reasoning (to solve What . . . if questions), straightforward causal reasoning (to specify relations among actions, situations, and events), and temporal reasoning (to include the idea of continuous change for time-critical systems).

Version 4.0 of PC Plus is to be announced this month. It is based on protected-mode Scheme, will address up to 4MB of extended memory, and will have faster graphics, among other enhancements.

PC Plus's ease of use and ability to exploit or waive its high-end capabilities make it an excellent development environment for both novice and veteran expert-system developers. This expert system shell provides a good amount of power and flexibility for a reasonable price.

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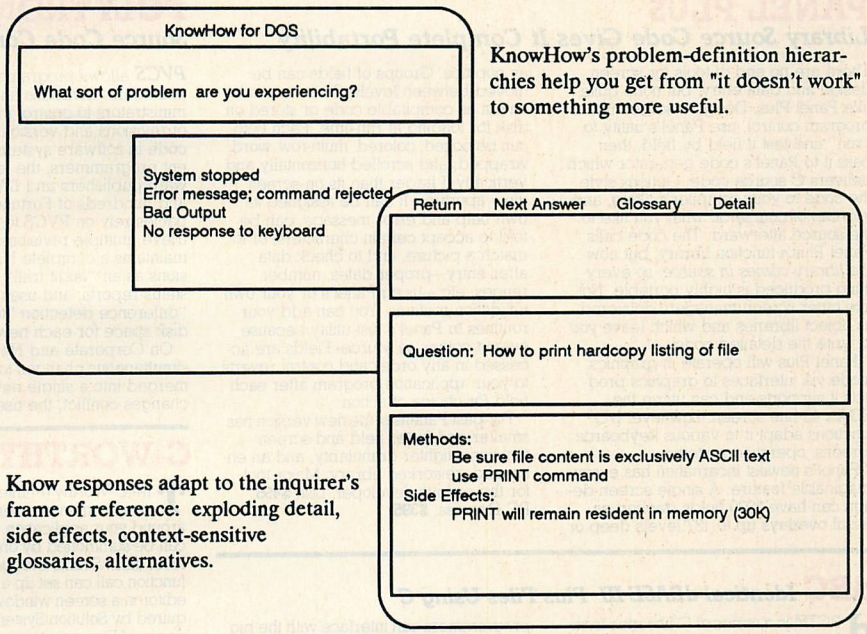

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C-TREE & R-TREE

B-Tree File Manager Now Has Report Generator

c-tree: The only major b-tree file manager with network support in the standard low-cost version. c-tree™ gives you record-locking routines for DOS 3.1/3.2, UNIX and XENIX, and it even comes in C source code, yet there are no royalties. Source sticks to K&R , so c-tree is portable. Tests in many environments prove it.

Permits any number of keys for a data file—alpha, numeric, even floating point. Handles files with varied record lengths, multiple keys in one index file. Both high level and decomposed functions. It's the works.

r-tree: Adds the ability to produce ad hoc reports from files maintained by c-tree (v. 4.1 and up). Link a file description to the r-tree™ library, and use any text editor to write report scripts with no further C coding. Reports can access data in several files, select on criteria, join findings into new logical records, sort them, calculate new fields and columns, tabulate by control breaks. Comes in source, same portability as c-tree, and fits any compiler.

	List:	Ours:	Combined:
c-tree:	**$395**	**$299**	**$499**
r-tree:	**$295**	**$235**	

WINDOWS for DATA

M'soft Windows Compatible

"Onlt one package can be easily recommended" said *Computer Language* (June '87) reviewing nine window and data entry products for C. Complete field level functions specify prompt string, field length, data type, screen location, picture, target variable, entry rules, help messages, even functions to call for validation once data keyed in.

Windows for C is a subset. No data entry but all windowing functions. Unlimited windows can be made either to pop up or permanently overwrite the screen, scroll and highlight lists vertically and horizontally. Specify Compiler. Windows for Data: List **$295**, Ours **$259**. Windows for C: List **$195**, Ours **$149**.

BLAISE C TOOLS PLUS/5.0

C TOOLS PLUS/5.0 from Blaise Computing Inc. helps you to quickly build professional applications using the full power of Microsoft C 5.0 and QuickC. Now you can concentrate on program creativity by having full control over DOS, menus, interrupt service routines, memory resident programs, fast direct video access; windows; printer and keyboard control, and more!

Blaise Computing's attention to detail, like the use of full function prototyping, cleanly organized header files, and a comprehensive, fully-indexed manual, makes C TOOLS PLUS/5.0 the choice for experienced developers as well as newcomers to C.

C TOOLS PLUS/5.0 prebuilt libraries are ready to use with either QuickC or the Microsoft C 5.0 command line environment. Complete documented source code is included so that you can study and adapt it to your specific needs.

	List:	PC Express:
C TOOLS PLUS/5.0	**$129**	**$ 99**
Turbo C TOOLS	**$129**	**$ 99**
C ASYNCH MANAGER	**$175**	**$135**
Turbo POWER TOOLS	**$ 99**	**$ 75**
Turbo ASYNCH PLUS	**$ 99**	**$ 75**

PANEL PLUS

Library Source Code Gives It Complete Portability

There are no end of tools for screen design and data entry, but none quite like Panel Plus. Design a screen under program control, use Panel's utility to "run" and test it field by field, then pass it to Panel's code generator which delivers C source code. Options style the code to your compiler's liking, and you can of course do what you like to the source afterward. The code calls Panel Plus's function library, but now *the library comes in source,* so everything produced is highly portable. Not like other screen managers delivered as object libraries and which leave *you* to write the detailed code.

Panel Plus will operate in graphics mode via interfaces to graphics products it supports and can utilize the EGA's 43-line screen. Low-level I/O functions adapt it to various keyboards, screens, operating systems.

Panel's newest incarnation has every imaginable feature. A single screen design can have 1000 fields stacked as visual overlays up to 127 levels deep or as pop-ups. Groups of fields can be moved between levels. Screens can be output as compilable code or stored on disk for loading at run-time. Each field can be boxed, colored, multi-row, word-wrapped, and scrolled horizontally and vertically if larger than its on-screen view aperture. It can be assigned its own help and error message, can be told to accept certain characters, or to match a picture, and to check data after entry—proper dates, number ranges, etc.—using Panel's or your own validation routines. You can add your routines to Panel's test utility because even it comes as source. Fields are accessed in any order and control reverts to your application program after each field for choice of action.

For past Panelists, the new version has smaller and faster field and screen functions, tighter granularity, and an enhanced, reworked library. Major tool for the serious developer. List: **$495**, PC Express: **$395**.

POLYTRON VERSION CONTROL

Source Code Control for Any Language

PVCS allows programmers, project managers, librarians and system administrators to control the proliferation of revisions and versions of source code in software systems. Independent programmers, the leading software publishers and LAN companies, and hundreds of Fortune 1000 companies rely on PVCS to store and retrieve multiple revisions of text. It maintains a complete history of revisions as an "audit trail", generates status reports, and uses intelligent "difference detection" to minimize disk space for each new version.

On Corporate and Network PVCS simultaneous changes to a module are merged into a single new version. If changes conflict, the user is notified. The "Logfiles" used to track changes are interchangeable between any PVCS product.

Corporate PVCS is for multiple programmers. It includes "branching" to maintain code when programs evolve on multiple paths. Personal PVCS offers most of the power and flexibility of corporate PVCS, but excludes multiple programmer features. Network PVCS is the Corporate version for LANs. File locking and security levels can be tailored to each project.

Ask for:	List	PC Brand:
Personal PVCS	**$149**	**$129**
Corporate PVCS	**$395**	**$329**
Network PVCS	**Call**	**Call**
PolyMake	**$149**	**$129**

dBC *Identical dBASE III Plus Files Using C*

dBC™ is a series of C libraries from Lattice which creates, accesses and updates files identical to those of dBASE itself. So dBASE can read and update the files too.

What for? It means both C and dBASE applications can operate on the same data bases interchangably. It means C programmers can interface with the big market of dBASE users out there, yet side-step the dBASE language. It means dBASE applications can now be linked to the universe of C libraries and tools to add windows, graphics, statistical analysis, all the things dBASE cannot do. It means the speed and power of C to impress clients accustomed to dBASE!

dBC's functions parallel all dBASE's file handling commands, many decomposed to permit direct data manipulation. Our versions of dBC mimic file formats for dBASE II and III and now dBASE III Plus makes your programs network ready!... as many stations as a network allows. Hands-off mode handles record and file locking and unlocking automatically. Close in functions give you direct lock/unlock control.

Supports all four memory models. dBASE II, III...List: **$250**, Ours: **$175**. dBASE III Plus...List: **$750**, Ours: **$595**. Call for Source Code Pricing.

C-WORTHY INTERFACE LIBRARY

The C-Worthy™ Interface Library wraps an entire user interface around your application. Its full power can be summoned by only a few high level calls. Sound exaggerated? A single function call can set up a complete text editor in a screen window. Recently acquired by Solution System, over 600 pages of Documentation, Turbo and Quick C version and a complete Interface Library have been added.

- High level calls pop menus and scrollable choice lists to the screen, restoring the background when dismissed.
- Windowing facilities open portholes of up to screen size for viewing virtual screens larger than the physical screen.
- Full context-sensitive help screen management takes over these chores and error messages. Automatic routines interrupt with pageable text windows explaining what to do next.

Novell found it "played a key role and accelerated development" in making its NetWare™ utilities easier for users. Ingenious demo: call for it.

Ask for:	List:	PC Express:
C-Worthy	**$195**	**$159**
with Forms Library	**$295**	**$269**

THE SPINDRIFT LIBRARY

Fully Functional Fortran Library.

Spindrift's smooth package offers something previously unavailable to the Fortran buffs...a basket of functions, packed to the brim. No more tedious coding. Just call on Spindrift with it's armoury of functions.

Any number of Windows may be defined, each with a striking border and brilliant color. Define "pop-up" screens, Save/Restore images, set Cursor shape. Snare an entire screen into a Character array.

The Keyboard; read it without echo, or sense any keypress during execution. Cursor controlled directly with Edit keys.

DOS interface includes: Call System, Call Exec, Findfrst/Findnext for (*) and (?) file searching. Search the Path, subdirectory and file manipulation, command line argument parsing, date/time functions, DOS environment access, and much more. Other utilities also included.

Specify compiler, Microsoft or Ryan McFarland. List: **$149.00**. Us: **$129.00**

Payment: We honor MasterCard, Visa, American Express (no surcharge), checks in advance, or funds wired to PC Express, c/o Chemical Bank, 126 East 86 St., New York, Account 034-016058. COD (U.S. only) for cash, money order, certified check (no fee). NY State, add sales tax. Purchase orders accepted from larger corporations and institutions at our discretion if you agree to net 30 days plus 2% a month late penalty thereafter.
Shipping & Handling: U.S.: UPS Surface: 1st product $6, each add'l $3. UPS 2nd Day Air: 1st product $12, each add'l $6. UPS Next Day Air and Federal Express shipment costs based on weight. International: Charges vary by destination and carrier. $10 per shipping container for export forms. Air parcel post at your risk beyond collected insurable amount.

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PC EXPRESS™ PROGRAMMER'S WORKBENCH

dBASE AT THE SPEED OF C

dBx Translates dBASE Applications to C

You dBASE™ programmers know what an expressive and readable language dBASE is. It's a very comfortable development environment. But the price is debased performance. Even compiled dBASE doesn't offer the speed that some users require these days. The kind of speed offered by software written in the C language. The answer is dBx™.

dBx translates dBASE to C. It offers you a major competitive advantage over the next dBASE programmer: Keep writing in dBASE. Take every application all the way to completion. Then use dBx to translate them top to bottom to C!

Other advantages: C is portable, even to other operating systems like UNIX/Xenix™. To the Macintosh or Amiga. dBx gives your applications a passport to places dBASE cannot go.

Has its own file manager for single user, but links to major C file managers—c-tree and dBC—for compatibility with dBASE files or multi-user support. We have everything you'll need, including good advice.

	List:	Ours:
dBx	**$550**	**$419**
with Library Source	**$950**	**$725**
Call for Full Source Pricing		

BRIEF/dBRIEF

The Power Environment for dBASE Programming

Many worthy utility products supply needs that dBASE®'s programming language doesn't—dUTIL™, dFLOW™ and a host of others. Trouble is, you have to use them separately, then combine their output into your dBASE program files.

No longer. dBRIEF™, written in BRIEF's macro language, grabs hold of BRIEF and turns it into a complete dBASE III and III Plus programming domain. Using BRIEF's underlying shell capabilities and its own interfaces, dBRIEF can run external utility libraries, plus dBASE itself, and link to the Clipper™, Foxbase+™ and Quicksilver compilers, all with dBRIEF still loaded and running the show. It can do what BRIEF already does plus:

- Convert a screen layout into dBASE code for interactive data entry.
- Display dBASE file structures in windows, a great convenience alongside your program files.
- Expand keystrokes into full dBASE statements.
- Indent automatically for clegic display.
- Create databases; index files; invoke Ashton-Tate's dFORMAT™ and dCONVERT™; draw lines and boxes.

"Simply marvelous programming environment for writing and editing dBASE programs.", *PC Magazine*, 7/86. Source code included!

Requires BRIEF 1.32 or later and 384k; 512k to run dBASE within dBRIEF; 640k and harddisk recommended.

BRIEF/dBRIEF...List **$275**,Ours: **$219**.

APPLICATIONS PLUS For dBASE

The Complete dBASE Companion

Who says you can't have it all?

APPLICATIONS PLUS has *everything* you need to get the most out of dBASE: An application generator (QUICKCODE PLUS), relational report writer (QUICKREPORT), and graphics system (dGRAPH).

QUICKCODE PLUS offers *dozens* of features you've *never* seen before in a dBASE code generator. Relational applications that read, display, and update a dozen or more databases simultaneously. "Real-time" calculations, performed *on screen* as the user enters each field. Forms up to 11 screens long, with the ability to pass data between screens. Computational formulas that automatically combine data from *different* databases. 9 Data types. 16 field types.

QUICKREPORT is a full-featured relational report writer, which combines up to 6 databases in one report, handles many-to-one relations, fancy printer features (like **bold** and *italics*), computed fields, and up to 16 levels of totalling and sorting.

dGRAPH is a graphics system that produces bar, pie, line, and piebar charts directly from dBASE data. Dozens of options let you tailor graphs to your needs.

APPLICATIONS PLUS is 100% compatible with Clipper and FoxBASE+.

	List:	Ours:
APPLICATIONS PLUS	**$299**	**$249**
QUICKCODE PLUS	**$295**	**$170**
QUICKREPORT	**$295**	**$170**
QUICKENTRY	**$ 99**	**$ 59**

MICROSOFT LANGUAGES

Powerful Implementations Of The Most Popular Programming Languages

Microsoft C 5.0: The flagship of the Microsoft line runs up to 30 percent faster than its predecessor. Its new optimization features deliver untouchable execution speeds, 100 new additional library routines...

Microsoft MacroASSEMBLER 5.0: If you ever wanted to take on the challenge of assembly, here's your opportunity. "MASM" 5.0 is a lot easier to use, has completely revised documentation, and a new "Mixed Language" programming guide that gives you step by step instructions for linking your assembly code with other Microsoft languages.

Microsoft QuickBASIC 4.0: is a revolutionary concept in BASIC programming. It allows you to run, edit, debug, and run again. Our friends at Microsoft have eliminated the dreaded compile step. Whenever you edit your code QB4 automatically incorporates your changes, so that it can run a program of 150,000 lines in less than a minute.

Each member of this language family includes the renowned debugger CODEVIEW.

	List:	Ours:
Microsoft C	**$450**	**$295**
Microsoft Macro-ASSEMBLER	**$150**	**$109**
Microsoft QuickBASIC	**$ 99**	**$ 66**
Microsoft FORTRAN	**$450**	**$295**

NOVELL: BTRIEVE, XQL, XTRIEVE

Sophisticated Tools Essential For Fast Database Handling

Btrieve is a library of subroutines that allows the programmer to build a database application using any language. It takes complete charge of all file creation, indexing, reading, writing, insertion, deletion, forward and backward searching. Its balanced tree indexing scheme finds any key in a million in less than 4 accesses...That's fast!

Btrieve is multi-lingual also. It includes more than 20 language interfaces (including C, BASIC, PASCAL, FORTRAN). However if it turns out that you are using something a little unusual, worry not. The manual includes a chapter on how to write a language interface to Btrieve.

Btrieve's vital statistics are equally impressive. Files may have up to 24 indexes; fixed record length to 4090 characters; variable length to 64K; indexes to 255 characters; files of 4 billion bytes. Network support includes Novell, 3-COM, IBM PC NET, Software Link's Multilink and many others.

XQL is a relational database management system designed especially for programmers. Imagine being able to access your database with the ease of SQL (Structured Query Language) statements and still having the power to process that data right down to the byte level.

Think about your applications. A large part of your software development effort is probably devoted to managing data stored in files on disk. Hours spent writing lines of code to search and store data records could have been used to program more important parts of your application. Why not let XQL do it for you. XQL will increase your programming productivity and let you focus on building better applications.

The XQL system works in tandem with Btrieve and has an equally powerful chassis...No limit on the number of records per file. Max. file size is 4 gigabytes, Max. record size equals 4K, Max. indexes per file is 24. The one version works for single or multiuser systems, DOS Ver 3.0 or greater. All languages are supported.

Xtrieve is the final ingredient in the Novell programming recipe. It is a menu driven, data retrieval system, that allows you to quickly find information and display reports. System developers can easily customize Xtrieve to display command menus, help files, and error messages in the English spoken by the customer. Xtrieve screens then gives menu choices that users can quickly recognize, making Xtrieve an easy product to use and understand.

Report Option for printing customized reports, form letters, mailing labels & statements.

	List:	Ours:
Btrieve	**$245**	**$175**
Btrieve/N	**$595**	**$445**
XQL	**$795**	**$595**
Xtrieve	**$245**	**$220**
Xtrieve/N	**$595**	**$459**
Report Option	**$145**	**$128**
Report Option/N	**$345**	**$269**

GSS GRAPHICS SYSTEM

Leave the Device Driving to GSS

For serious applications stick to the tools that stick to the standards. Not the least of reasons why GSS™ has emerged as the pre-eminent graphics toolmaker is that it has always conformed to ANSI standards.

At the heart of the system is the CGI standard Development Toolkit. It has all language interfaces and device drivers for keyboards, mice, joysticks, tablets, printers, plotters, cameras. The drivers completely insulate your application from concern for device idiosyncracy.

GSS Kernel™ conforms to ANSI's GKS 2b and has all its drivers and language bindings. Macro level tools to draw, color, segment, transform, store and recreate an object. The Metafile Interpreter reads ANSI CGM files with full CGI capability for recreation on various devices.

Quality software? IBM thinks so. They sell GSS under their own label. Royalties. Needs 256k.

	List:	Ours:
CGI Dvlpment Toolkit	**$495**	**$425**
Kernel System	**$495**	**$425**
Kernel for IBM RT	**$795**	**$645**
Metafile Interpreter	**$295**	**$265**

CLIPPER $399

R&R RELATIONAL REPORT WRITER $129

MORE PROGRAMMING TOOLS FOR...

dBASE, C, FORTRAN, BASIC, COBOL, PASCAL

dbc ISAM, FoxBASE, Greenleaf, Halo '88, Logitech MODULA, MicroFocus COBOL, Norton Utilities, Panel Plus, Periscope, Phoenix, Polytron, RM/COBOL, Sprindrift, Tom Rettig's Library, Windows for Data...and many more.

Call or write for prices and information.

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FRONTRUNNER *(a new Ashton Tate product created by Apex Software)*

FrontRunner generates memory-resident **pop-up** applications using the dBASE III Plus or dBASE IV programming language. Once your memory-resident program is created, **pop-up** your program while using Lotus 1-2-3, any dBASE program, Clipper, Basic, any word processor, DOS or any program written in any language. Pop-In and Pop-Out of any software package instantly. All data files and indexes created are dBASE compatible. FrontRunner applications can be compiled into binary files for protected distribution and unparalleled speed. The user selects a hot-key to call up an application. Use the unique POWERKEY feature to define additional hot-keys within the application. A powerful paste command allows the user to extract data from a FrontRunner application into a word processor, spreadsheet or other application. Use FrontRunner for **pop-up** help screens, account listings, phone directories, schedules, random notes, printing mailing labels.... anything imaginable.

FrontRunner....List: **$295**, Ours: **$195** *(new low price!)*

GREENLEAF LIBRARIES

Functions

C source, assembler source, and binary libraries of 225 functions for many compilers. Emphasizes tight functional groupings to minimize loading code which your application may never use. Manual's 250 pages help select functions, as do demos, bulletin board.

Communications

Communicate from within your own C programs! Over 120 functions and demo programs in C and assembler source to set up interrupt-driven asynch communications for up to 16 channels. Up to 9600 baud, ASCII or binary, any parity or word length, 8250 UARTs, Xon/Xoff and Xmodem, WideTrack receive. Goodbye separate communications software. Specify compiler.

Data Windows

Windows, menus and data entry do work together...when you utilize Greenleaf's screen architect. This smooth screen designer offers device independence, logical windows, table driven data entry and economical pricing. Source code is also available.

	List	Ours
Communications	**$185**	**$139**
Functions	**$185**	**$139**
Data Windows	**$295**	**$249**
Complete 3 in 1 Pack	**$665**	**$475**

Shopping List for the Power Workbench

	LIST	US
ASSEMBLER		
Microsoft Macro Assembler with Utilities	150	109
PASM 86 *by Phoenix, Macro Assembler*	195	109
ASSEMBLER Support		
Btrieve Softcraft's File Manager	245	175
GSS CGI....*Device independent graphics*	495	425
BASIC		
Microsoft BASIC Interpreter..*for XENIX*	350	249
Microsoft QuickBASIC...*Ver 4.0*	99	66
Turbo BASIC.....*NEW from Borland*	100	75
BASIC LIBRARIES & UTILITIES		
Btrieve Softcraft's File Manager	245	175
GSS CGI....*Device Independent Library*	495	425
Halo Graphics by Media Cybernetics	325	249
C LANGUAGE COMPILERS		
C86 PLUS by Computer Innovations	497	397
Lattice C Compiler Now ver 3.2	450	299
Let's C Compiler from Mark Williams Co	75	55
Mark Williams C full development system	495	369
Microsoft C Compiler with free CODEVIEW	450	295
Microsoft QuickC....*Special Price*	99	66
Turbo C.....*New from Borland*	100	75
C LIBRARIES—Communications		
Asynch Manager by Blaise	175	135
Greenleaf Communications	185	139
Essential Communications	185	125
Essential Communications Plus	250	189
C LIBRARIES—FILE MANAGEMENT		
Btrieve Softcraft's File Manager	245	175
Btrieve/N File Management for Networks	595	445
Ctree by Faircom,with full source	395	299
Rtree...*Report Gen. for Ctree*	295	235
Ctree & Rtree.....*Special Combination*	650	499
dBC ISAM Accesses dBase files	250	175
with Source code	500	349
dBC III Plus multiuser	750	595
with Source code	1500	1195
Opt Tech Sort Super fast sort for Btrieve	149	105
XQL....SQL *from NOVELL*	795	595
C LIBRARIES—Graphics		
Essential Graphics...*no royalties*	299	225
GSS CGI....*Device independent graphics*	495	425
GSS Metafile Interpreter stores images	295	265
Halo '88 by Media Cybernetics	325	249
Halo for Microsoft Languages	595	434
C LIBRARIES—Screen Design		
Curses from Lattice,UNIX lookalike	125	99
with source	250	199
C Worthy....*by Custom Design Systems*	195	159
C Worthy with Forms	295	269
Greenleaf Data Windows	295	225
Microsoft Windows Dev. Toolkit	500	365
Panel Plus by Roundhill	495	395
View Manager for C,Blaise	275	199
Vitamin C...*Creative Programming*	225	198
VC Screen...*Source code Generator*	100	81
Windows for C	195	149
Windows for Data	295	259
Zview....*Data Management Consultants*	245	175
C UTILITY LIBRARIES		
Basic C....*Basic-like routines for C*	175	139
Blaise C Tools Plus/5.0....*f/MsC & QuickC*	129	99
Blaise Turbo C Tools....*f/TurboC*	129	99
C Food Smorgasbord by Lattice	150	109
C Utility Library by Essential,300 functions	185	119
Greenleaf Functions	185	139
PforCe by Phoenix, vast library	395	199
OTHER TOOLS		
BASTOC....*JMI,Translates BASIC to C*	495	399
dBX Translator.....*dBASE to C translator*	550	419
with Library Source	950	725
Pre/C....*by Phoenix, like UNIX lint*	295	154
PC-LINT..*by Gimpel, subset of UNIX Lint*	139	125
COBOL		
Micro Focus COBOL/2	900	795
Micro Focus Toolset	900	795
Micro Focus Personal COBOL	149	134
Microsoft COBOL inc. COBOL Tools	700	499
for XENIX	995	749
RM/COBOL...*by Ryan McFarland*	950	675
RM/COBOL 85...*ANSI 85*	1250	895
COBOL Support		
Btrieve Softcraft's File Manager	245	175
GSS CGI....*Device independent graphics*	495	425
Halo.....*from Media Cybernetics*	325	249
RM/Screens..*Screen generator*	395	335
RM/Net+ 5...*R/M COBOL networking*	300	249
DBASE & RELATED PRODUCTS		
Applications Plus....*Fox & Geller*	299	249
Brief & dBrief..*Editor/Macro lang for DBase*	275	219
Clipper.....*Nantucket's DBase Compiler*	695	399
DATA-p.....*Wallsoft*	60	50
dBC III Plus supports multiuser commands	750	595
with Source code	1500	1195
dBC ISAM...*accesses dBase files*	250	175
with Source code	500	349
dBX Translator.....*dBASE to C translator*	550	419
with Library Source	950	725
dFlow.....*Wallsoft*	149	124
Documenter.....*Wallsoft*	295	244
FoxBase+.....*Fox Software*	395	219
Multiuser version	595	349
QuickCode Plus.....*Fox & Geller*	295	170
QuickEntry.....*Fox & Geller*	99	59
QuickReport.....*Fox & Geller*	295	170
UI Programmer....*Wallsoft*	295	244
FORTRAN Compilers & Utilities		
Btrieve: Softcraft's File Manager	245	175
GSS Graphics Development Toolkit....*CGI*	495	425
GSS GKS...*Kernel Sys,ANSI Level 2b*	495	425
Halo '88.....*from Media Cybernetics*	325	249
Microsoft Fortran..*Ver 4.0,inc. Codeview*	450	295
for XENIX	695	499
R/M Fortran...*ANSI 77 by Ryan McFarland*	595	425
for XENIX	750	599
Spindrift Library....*By Spindrift Labs*	149	129
PROLOG		
APT..*PROLOG Tutor*	65	59
Arity PROLOG Compiler & Interpreter	650	569
Arity PROLOG Interpreter	295	229
Arity Standard PROLOG	95	77
PROLOG-86 Plus.....*Solution Systems*	250	199
Turbo PROLOG...*Borland Intl.*	100	75
Turbo PROLOG Toolbox...*Borland*	100	75
TEXT EDITORS		
Brief.....*from Solution Systems*	195	155
dBrief..*Macro lang for Brief & DBase*	95	75
Brief & dBrief Combo	275	219
Condor Editor....*Condor Corp SUPER SALE*	130	65
Epsilon.....*Lugaru*	195	149
KEDIT.....*Mansfield..identical to XEDIT*	125	99
KEDIT Ver. 4.0	150	119
Pmate.....*Phoenix*	195	109
Vedit Plus.....*Compuview*	185	129
DEBUGGERS		
Advanced Trace 86.....*Morgan*	175	119
C-Sprite....*Source debugger for Lattice C*	175	139
Periscope I...*Board, Switch, Software*	345	289
Periscope II..*Breakout Switch & Software*	175	139
Periscope II.....*Software only*	145	105
Periscope III....*8 Mhz*	1095	875
Periscope III...*10 Mhz*	1195	975
Pfix 86 Plus....*Phoenix symbolic debugger*	395	199
LOGITECH		
MODULA-2 Compiler Package	99	79
MODULA-2 Development Pkg	249	199
MODULA-2 Toolkit	169	139
MODULA-2 ROM Package	299	239
MODULA-2 Window Package	49	39
PHOENIX		
Pasm 86.....*Macro ASSEMBLER*	195	109
Pdisk.....*Disk Management Utility*	145	95
PFantasy.....*six-pack take-away*	995	569
PFinish.....*Profiler*	395	199
PFix 86 Plus.Symbolic Debugger	395	199
PForCe.....*Utility library*	395	199
PforCe...*Pforce for C*	395	199
PLink 86+...*sophisticated overlay linker*	495	269
PMaker.....*make utility*	125	74
Pmate.....*Text Editor*	195	109
Pre-C.....*Super-set of UNIX Lint*	295	154
Ptel.....*Binary Transfer Program*	49	39
POLYTRON		
PolyBoost....*Software accelerator*	80	64
PolyDesk III..*3rd Generation Desktop org*	99	73
PolyLibrarian...*Library Manager*	99	89
PolyLibrarian II	149	129
PolyMake.....*Complete MAKE Utility*	149	129
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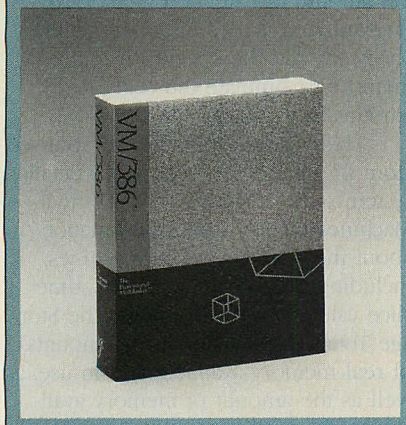


CIRCLE 330 ON READER SERVICE CARD

Several products are now available that allow the simultaneous execution of multiple DOS applications on 80386-based computers. These products use the 386's virtual 8086 mode and a single copy of DOS to run each of the applications in a separate 8086 virtual machine. VM/386, The Professional MultiTasker, from Intelligent Graphics Corporation (IGC), takes the process one step further by running each application and its copy of DOS (not necessarily the same version) in a separate virtual machine. This makes for flexible application support, albeit at the expense of additional physical memory consumption.

VM/386 is a single-user system that supports as many as ninety-nine 8086 virtual machines, limited only by available memory. It is not an operating system; it is a virtual machine manager that is loaded from DOS. VM/386 runs on the IBM Personal System/2 Model 80, Compaq Deskpro 386, and compatible computers. At least 2MB of memory is recommended to run VM/386; a hard disk is not required but is recommended. VM/386 supports the VGA, CGA, EGA, MDA, and Hercules Graphics Card. One monochrome and one color graphics adapter may be used simultaneously.

VM/386 consists of two diskettes and a spiral-bound user's manual in a slip-case package. The software is contained on both a 1.2MB 5.25-inch diskette and a 720KB 3.5-inch diskette. Once installed, VM/386 is initiated by accessing its directory and entering the command VM386. This brings up a title screen, followed by the first of a set of hierarchical main menus. From this first menu, the user may access additional menus that control the VM/386 virtual machines and system hardware and options. Also accessible are menus that display system status and help information. The main menu is used to exit VM/386 (which causes the computer to reboot).

The Virtual Machine Control menu is used to create, terminate, update, or reinitialize a virtual machine. This menu also is used to update profile files that define the characteristics of created virtual machines. Finally, the Virtual Machine Control menu is used to define a startup file that defines the overall characteristics of the VM/386 system, including the configuration of virtual machines to be initialized when VM/386 starts.

Virtual machines are created based on profiles listed on the Create Virtual Machine menu. Each profile contains parameters that determine the exact characteristics of the virtual machine to be created. In addition to specifying the name and memory size of the virtual machine and whether or not it is to run only when it is in the foreground, the profile specifies not only the device from which the virtual machine is to be initialized, but also the names of the files to be used as its AUTOEXEC.BAT and CONFIG.SYS files (see photo 1).

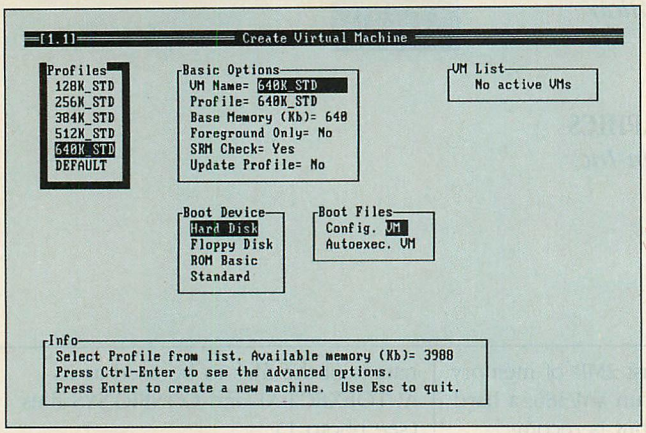
Virtual machines are accessed using the VM/386 Switcher menu, which is used somewhat like the OS/2 Program Selector. The menu can be accessed at any time by pressing the SysRq key (Alt-PrintScrn on the 101-key enhanced keyboard). The desired virtual machine is selected from a list (either by using the cursor keys or by entering the number of the virtual machine) and then pressing Enter. Applications can use a mouse, but the virtual machine manager itself does not support one.

When control is switched to a virtual machine, its virtual display image is switched to the physical display. Only the display of output from one virtual machine at a time can be viewed. Products that display output, such as the non-386 versions of Microsoft Windows and Quarterdeck's DESQview, can be run in a virtual machine.

Applications, including any required terminate-and-stay-resident utilities, run in a virtual machine as if they were running on their own 8086 computer. Depending on the version of DOS, as much as 600KB of memory is available for the application's use.

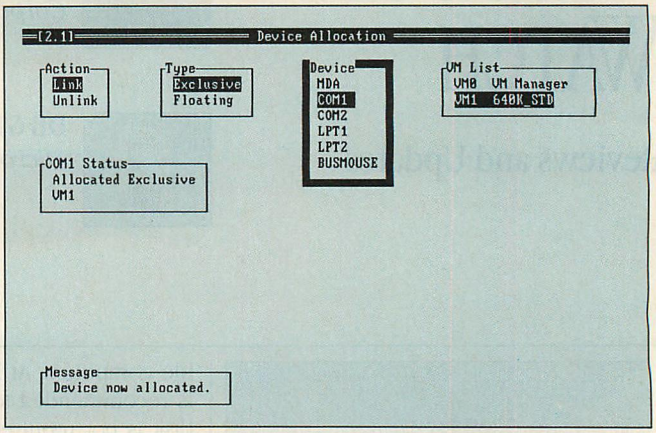
Before an application can use a nonshareable device (such as a printer or communications port), it must be assigned to the virtual machine using the Hardware Control menu. This menu may be accessed even after an application has started by using the Switcher to access the Virtual Machine Manager. The Hardware Control menu may be used to access menus that display the virtual devices allocated to each virtual machine, and allocate devices among virtual machines. Devices can be assigned exclusively to one virtual machine at a time or to multiple virtual machines on a floating basis (see photo 2).

PHOTO 1: *Create Virtual Machine Menu*



Profiles listed on this menu specify the name and memory size of the virtual machine to be created and the device from which the virtual machine is to be initialized.

PHOTO 2: *Device Allocation Menu*



Nonshareable devices are assigned to a virtual machine using this menu. Devices can be assigned to one virtual machine or to multiple virtual machines on a floating basis.

The Systems Options menu can be accessed from the main menu to change the VM Manager screen attributes and VM/386 performance options. This menu is used to set the number of additional time slices the foreground virtual machine is to receive. In addition, it defines whether or not the System Resource Manager (SRM) is to be active and whether it will analyze foreground tasks.

The SRM is a VM/386 module that automatically monitors the activity of virtual machines, adjusts time slices for optimum system performance, and suspends inactive virtual machines (by giving them no time slices). It can suspend the foreground machine if it becomes inactive. If the SRM is turned off, each inactive and active virtual machine in turn receives a 6-millisecond time slice.

The SRM can be activated or deactivated for specific machines using menus that create, update, or reinitialize a virtual machine, or with the Update a Profile File menu. The Create a VM and Update a Profile menus contain advanced option menus that allow a virtual machine's time slice to be set to a particular value (in milliseconds). This advanced options menu also is used to specify primary and secondary video, disk devices, and the amounts of nonconventional (extended and expanded) memory required for the virtual machine. VM/386 allows applications in the virtual machine to access the amount of extended memory requested, and it uses the 386's paging hardware and the system's extended memory to simulate the requested amount of expanded memory.

The Status Display menu (accessed from the main menu) provides detailed system status information. Its Virtual Machines display shows information about the system's virtual machines, including their current priority, time-slice value, and control flags. The Storage Totals display shows the amounts of real memory available and in use, as well as the amount of memory available and actually being used by the virtual machines. The Storage display can show any memory address within any virtual machine. Selecting the Async

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- **Professional Pascal ™:**

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Debug menu from the Status Display Menu provides access to the VM/386 debug utility (if access to the VM/386 Debug option has been set in the VM/386 Performance Options menu). An asynchronous terminal is required to display the output from this utility.

The VM/386 documentation provides both reference and tutorial information; confusion is avoided by keeping the two types of information clearly separated. Basic operation of the system is well-defined, and detailed explanations of system functions and menus are given. The documentation is augmented by an extensive and well-formatted on-line help facility. The information files provided are extensive, yet are easy to read.

VM/386 offers great flexibility of operation. If desired, the user can start VM/386 and then configure and start each virtual machine as well as the application to be run in it. Although flexible, this method becomes tedious unless the user enjoys being a computer-console operator with the ability to create, reboot, and terminate virtual machines at will.

For day-to-day use, VM/386 has a powerful shortcut. Anytime VM/386 is running, the Virtual Machine Control Menu can be used to create a startup file, which contains information about all the virtual machines currently in operation, including their startup files and the devices allocated to them. This means that the user (or system supplier) can easily set up a system whereby VM/386 is automatically started when the system is turned on (using AUTOEXEC.BAT), and the user's most frequently used applications are started in separate virtual machines (using the appropriate CONFIG.VM and AUTOEXEC.VM files for each). By powering on the computer in the morning, the user can institute a process that calls MCI Mail and loads a word processor, spreadsheet, and any other desired application.

Once applications are started, switching among them using the SysRq key is straightforward, particularly since the names that appear on the VM/386 Switcher list can be specified when each virtual machine is created. Also, because VM/386 uses full-screen video for each virtual machine, it is easy to forget that VM/386 is being used.

VM/386 was tested on both a 16-MHz and 20-MHz PS/2 Model 80 as well as a 16-MHz Compaq Deskpro 386. Video equipment used included the Model 80's built-in VGA, and Compaq's color graphics (EGA-compatible) and video graphics controller (VGA-compatible) boards with appropriate displays. Communications and network operations were tested using Hayes internal 1200B and external 2400 Smartmodems and an IBM Token-Ring Network Adapter/A. Other equipment used included an IBM PS/2 mouse, a Microsoft serial-port mouse, and several parallel-port-connected printers, including a Hewlett-Packard LaserJet Series II and an Okidata 292. VM/386 performed flawlessly with all the equipment.

VM/386's ability to run a different version of DOS in each virtual 8086 machine was tested using DOS versions 2.1, 3.1, 3.2, and 3.3 in different virtual machines. All performed correctly, with the expected limitation that older DOS versions can use only a subset of the hardware supported by later versions. For example, a virtual machine running version 2.*x* cannot access a DOS 3.*x* formatted hard disk. It is doubtful that many users will need to run multiple versions of DOS, but it is handy for running an application that requires an older version of DOS. Furthermore, for real back-to-basics situations, VM/386 supports booting a virtual machine from IBM's ROM BASIC.

Applications used with VM/386 included Lotus 1-2-3 Release 2.01, Ashton-Tate's dBASE III PLUS, and WordPerfect 4.2, all of which ran smoothly and completely. Terminate-and-stay-resident programs including Borland's SideKick 1.56A worked well when loaded into a virtual machine.

Several applications that use EGA graphics were tested. These included Microsoft Word 3.11 and Windows 2.03, and RIX Softworks' EGA Paint 2005. The packages indeed ran as if they were each running on a dedicated machine. The full graphics screen for each application was restored quickly and completely when it was switched to the foreground. Operations using both the Microsoft and IBM PS/2 mouse were accomplished without problem.

Communications and network software included Crosstalk XVI 3.61, using the Hayes Smartmodems tested, and Novell SFT NetWare 2.1, using the IBM Token-Ring Network Adapter/A and IBM LAN Support program. All worked as expected. It was both possible and convenient to run asynchronous communications and network operations along with other tasks. The network software was run in the first virtual machine (VM1). As noted in the VM/386

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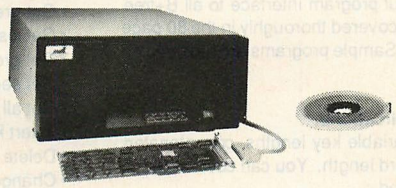

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README file, certain devices such as network cards and tape backup units, for which VM/386 does not have a device driver, must be used with the universal device driver included in VM1. VM/386 controlled the printers tested without difficulty, both when used locally and as network printers.

VM/386 provides crisp performance when running three or four tasks at once, which is as many as most users will likely run. As more tasks that remain active in the background are run, performance slows at an acceptable, predictable rate; most importantly, the system does not hang up.

VM/386 is an excellent product that delivers everything it promises. It is a comprehensive, well-documented virtual machine manager that allows the user or developer to capitalize on the power of the 386. VM/386 allows the convenient, worry-free operation of simultaneous DOS applications; its virtual machines are so compatible with the real thing that auxiliary features, such as windowing and cut-and-paste operations, can be left to products designed for these tasks. To sweeten the pie, IGC is working on a multiuser version as well.

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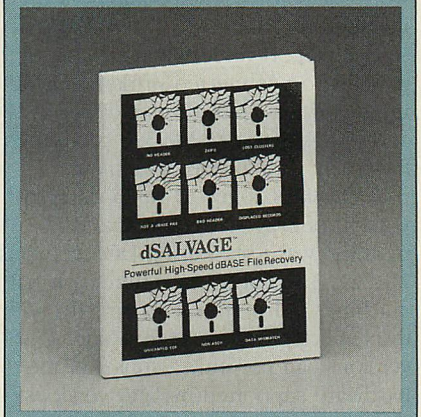

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Every serious dBASE programmer, systems manager, and user can benefit from dSALVAGE, a file-recovery utility from Comtech Publishing Ltd. This stand-alone program runs independently of dBASE and is used to repair various types of damage that can occur in dBASE database files. dSALVAGE is not copy protected and runs on any IBM PC, PC/XT, PC/AT, or compatible computer with sufficient memory to host dBASE; the minimum amount of RAM is 256KB, with 150KB free after DOS is loaded. It can be run from either a hard disk or a diskette drive.

The manual, which consists of a reference section and a tutorial, describes the damage that can occur in a dBASE data file and the possible causes of damage. Two damage categories are described: external and internal. External damage includes errors that would be reported by CHKDSK; internal damage includes errors that would be apparent only to dBASE or to a utility such as dSALVAGE. The section on file storage, file damage, and file recovery strategies is informative and practical.

The program disk contains the DSALVAGE.EXE program, several sample damaged data files for use in the tutorial, and a batch file to install the program and tutorial files.

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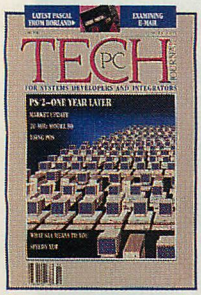

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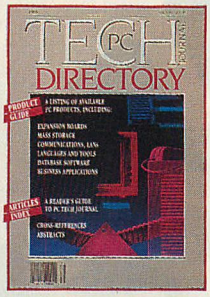

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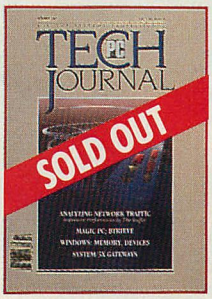

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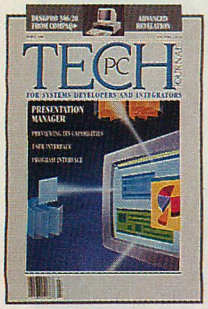

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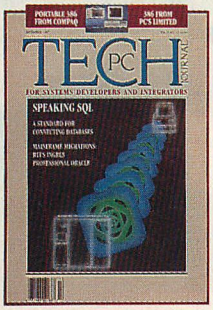

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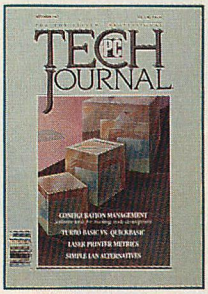

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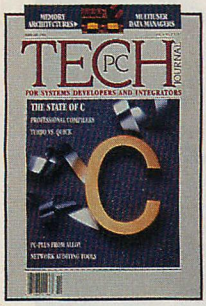

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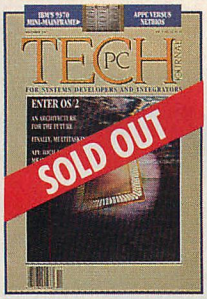

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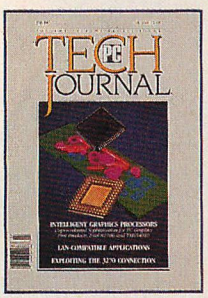

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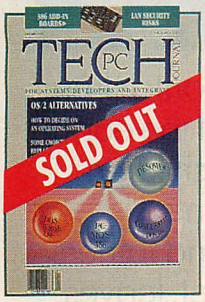

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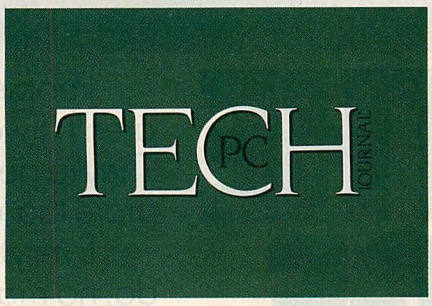

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Each submenu consists of a window describing a set of available actions. Function keys are used to select an action; dSALVAGE then provides windows to confirm file selection, to supply file data (such as header information, number of records, and type of damage), and to prompt for further actions. Context-sensitive, on-line help can be invoked with the F1 key. Help windows, as well as other status windows, are cleared from the screen with the Enter key.

The general strategy for repairing a damaged file is first to select the data file using the Setup and File Selection menu (accessible from the File Operations option), then diagnose and repair the damage from the Diagnosis and Repair menu.

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- Class 1 damage is spurious data in data file records, without displacement of records. dSALVAGE displays records with this type of error and replaces unprintable characters and non-ASCII values with spaces.
- Class 2 damage consists of end-of-file (EOF) markers occurring in the file before the actual end of file; dSALVAGE will remove the unwanted markers.
- Class 3 damage occurs when part or all of the data file header is overwritten, but the records remain undamaged. In this case, a new data file header must be constructed with dBASE; dSALVAGE will then read it into the damaged file.
- Class 4 damage occurs in a file that has an intact header but also has records containing spurious data that are displaced from the positions indicated by the header. dSALVAGE finds and displays the first displaced record. The program will align the displaced records automatically and allow manual alignment via the cursor keys. If desired, the program can remove the characters that caused the misalignment and update the data file header to reflect the correct number of records. The manual warns that this type of damage is usually associated with the loss of one or more clusters of data.
- Class 5 damage consists of damage from all of the first four categories. Like Class 3 damage, the repair procedure requires the construction of a new header before the actual recovery process can begin.

In order to repair external damage to a data file, CHKDSK must be run with the /F parameter. After this has been done, dSALVAGE then will scan the FILE*xxxx*.CHK files created by CHKDSK and integrate them with the damaged data file, using the header of the damaged file. This procedure creates a corrected output file, leaving the damaged original file unchanged.

When the precise nature of the damage cannot be determined, dSALVAGE examines the possibilities and prescribes a course of action for each. In virtually every case, the program does not proceed with repair operations until instructed to do so. dSALVAGE also will reconstruct a "zapped" file, as long as the deallocated clusters have not been reused by DOS.

In addition to the Diagnosis and Recovery functions, dSALVAGE includes three editors—header, record, and byte-stream. The header editor can be used to change the count field, the record size, the record count, the field count, and the version number. The field name, type, width, and number of decimal places also can be changed for any record. In addition to editing records, the record editor can be used to search for records by number or by example. The record editor displays a single record at a time (in the tradi-

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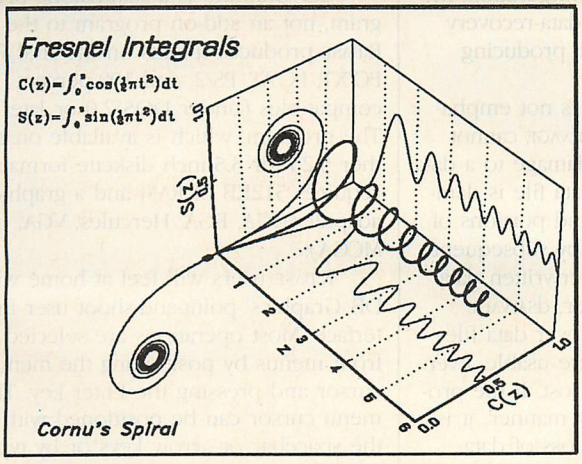

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tional dBASE manner). The byte-stream editor displays a window of unformatted data from the data file, allowing blocks of data to be deleted, moved, copied, and undeleted.

dSALVAGE is not for the inexperienced dBASE user. It can destroy a data file just as easily as it can repair one. Fortunately, dSALVAGE does prompt for confirmation at every stage critical to the integrity of a file (such as realigning characters, modifying header information, and writing changes to the output file). An experienced dBASE developer or user will find that the program offers considerable power, balanced with ease of use. With the requisite knowledge of dBASE and DOS, the new user should be able to get through the dSALVAGE tutorial and be up to speed in about an hour.

The manual mentions the possibility of a conflict between dSALVAGE and other terminate-and-stay-resident (TSR) software, but notes that it has been tested with a number of such programs with no problems encountered. During testing, no conflicts were observed with TSRs such as Borland International's SideKick, SuperKey, and Turbo Lightning, and VM Personal Computing's RELAY Gold. However, a problem was encountered using dSALVAGE on an IBM AT with several device drivers installed, such as Computervision's Personal Designer security box and Priam's Shared Space disk driver. Although dSALVAGE would display a few screens, it would not run. On an AT compatible with a more straightforward configuration, the program performed all data-recovery operations as advertised, producing usable database files.

Although the point is not emphasized in the manual, dSALVAGE cannot repair certain types of damage to a data file. If, for example, a data file is damaged at the DOS level and portions of the file are overwritten by subsequent write operations, the overwritten data are lost forever. However, dSALVAGE makes it possible to recover data files to the extent that they are usable, even though records may be lost. If the program is used in a timely manner, it is possible to prevent the loss of data.

Any damage done to a data file can undermine the integrity of an entire database. By using dSALVAGE, however, much of the potentially serious damage can be effectively repaired with minimal loss of records. This aspect alone makes dSALVAGE an essential companion to dBASE.

—VICTOR E. WRIGHT

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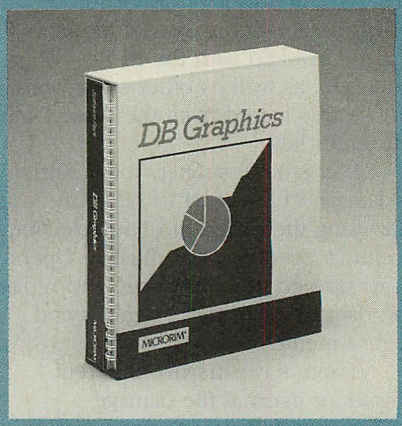

CIRCLE 332 ON READER SERVICE CARD

DB Graphics is a presentation graphics package from Microrim Inc., publishers of the R:BASE data manager series, including R:BASE for DOS (see "The Evolution of R:BASE," Victor E. Wright, this issue, p. 86). The program is used to present numeric data graphically. As expected, DB Graphics can plot data directly from the various R:BASE database files. DB Graphics also can plot data from dBASE III and III PLUS database files and from data sets created with its own data set editor.

DB Graphics is a stand-alone program, not an add-on program to the R:BASE products. It runs on the IBM PC, PC/XT, PC/AT, PS/2, and 100-percent compatibles (under DOS 2.0 or later). The program, which is available on either 5.25- or 3.5-inch diskette formats, requires 512KB of RAM and a graphics adapter (CGA, EGA, Hercules, VGA, or MCGA).

R:BASE users will feel at home with DB Graphics' point-and-shoot user interface. Most operations are selected from menus by positioning the menu cursor and pressing the Enter key. The menu cursor can be positioned with the spacebar or arrow keys or by typing the number or first letter of a menu selection. The interface has the same look and feel of R:BASE System V.

DB Graphics can be used to construct eight types of graphs—line, area, column, mixed, bar, pie, scatter, and high-low. These are the typical graph formats provided by most presentation graphics packages. With the use of a

blank graph file provided with the program, text-only slides can be prepared. The ability to add text in various fonts and sizes is also comparable to that of other programs.

With the exception of the pie chart, the graphs consist of *x* and *y* axes, an *x*-axis label, a legend (*y*-axis labels), a title and subtitle, graphics data, and free text. The pie chart consists of a circle divided into shaded segments, with a title and labels arrayed around the circle. DB Graphics allows the entry of free text; it also allows the moving of segments out of the circle for emphasis.

DB Graphics's strong point is that it reads R:BASE and dBASE III data files directly. Although many presentation graphics programs accept data from other programs, most of them use their own data file format, thereby requiring that data be imported. DB Graphics includes a data set editor to create data sets in the absence of data manager files. However, if data manager files are available, they can be used without any modification.

DB Graphics understands both R:BASE and dBASE database structures. When a new graph is created, the program displays a Data Source menu for selection of the type of database to use as the data set—R:BASE System V, R:BASE 5000, dBASE, or data file. The program then displays the available database files of the type selected. A Display menu provides selections to display the structure of a selected database, as well as the data contained in the database files. Because an R:BASE database is a single file containing several tables and a dBASE database consists of separate database files, the display of R:BASE is somewhat different from dBASE files.

Once a database is selected, the graph is built by selecting data sets for the horizontal and vertical axes. A data set consists of either a single column of an R:BASE table or a field of a dBASE data file. The entire process of selecting data sets can be accomplished by highlighting a selection and then pressing the Enter key.

Data sets need not be selected directly from the database. A data set can be defined with one or more variables, the values of which are derived from the database or from other variables. A variable has a data type and is defined as an expression containing operators, constants, and column/field function and variable names. Expressions are similar to those of R:BASE System V but are limited to 60 characters each.

A set of functions similar to the set provided in R:BASE System V is available. Included are arithmetic, mathematical, trigonometric, type conversion, date, time, and financial functions. In the set of operators are the expected arithmetic and the grouping operators (SUM OF, AVERAGE OF, MINIMUM OF, and MAXIMUM OF). Data sets can be sorted either in ascending/descending order or grouped by using variables and grouping functions.

Data can be selected from the data source by using conditions, which are set using a syntax similar to that used in an R:BASE WHERE clause. Comparison operators and logical operators can be used to compare column/field and variable values with other column/fields, variables, or values. Conditions are set by selecting items and operators from menus. Only values need be entered from the keyboard.

The data-set editor provides a means of either defining a data set directly or editing the contents of a data set derived from a database. The database is not modified, but changes can be saved as a data file.

Once the data set is defined and confirmed, DB Graphics displays the graph. The default format is the line graph; other formats can be selected from a menu. The style of the graph also can be edited. The Style menu is used to add a frame and grids; adjust the legend; change the baseline, range, and the patterns for filled areas and line types; set the axis type to linear or logarithmic; and stack or unstack line, bar, and column graphs.

A Text menu allows editing of the axis names, the legend, the format of labels on the axes, and the insertion of free-form text. The font and size of text entries also can be changed.

An Output Utilities menu includes selections to create, store, retrieve, edit, and display split-screen images of several graphs and slide-show sequences to print or plot a graph. A split-screen can contain a maximum of 32 windows, each of which can contain a different graph. Both split-screens and single graphs can be printed or plotted.

In terms of performance, graph formats, and hardware support, DB Graphics is comparable to other presentation graphics packages. However, its ability to read database files directly and select data conditionally should make it a strong contender for being chosen as the graphics component of an R:BASE or dBASE system.

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1 SEGMENT ORDER

2 OS/2 NUMLOCK

New tools and environments are always welcome, although they can create as many problems and anxieties as they solve. Discovering these problems is a learning exercise that many of us would rather read about than experience first-hand. Two such exercises—dealing with the simplified segment directives introduced in version 5.0 of the Microsoft Macro Assembler (MASM) and porting a seemingly trivial utility from DOS to OS/2—are worth discussing. I was bitten by incomplete and incorrect documentation for MASM 5.0 while struggling through an unexpectedly thorny process of getting OS/2 to turn off that pesky NumLock light at boot-up. The success of this effort resulted not only in a useful utility, but in illustrating some characteristics of the learning curve for the new environment.

1 SEGMENT ORDER IN THE ASSEMBLER

With version 5.0, MASM introduced a new set of directives for declaring segments. In effect, these directives are built-in macros that generate the same segment names and group structure that are produced by Microsoft high-level language compilers. This greatly simplifies the writing of procedures that are called from high-level languages, especially when interfacing with more than one memory model.

However, the documentation for the simplified segment directives is incorrect and incomplete. The error occurs on page 93 of the Microsoft Assembler *Programmer's Guide* in the table that lists the segment names, class names, and other attributes generated by the simplified segment directives. For two of the four segments that belong to DGROUP, the class names in Microsoft's table do not correspond to the actual names created by the assembler. The correct names are listed in table 1 below. A change between versions 5.0 and 5.1 is not documented in the update booklet. The class names of segments not in DGROUP (and all other segment attributes) are listed correctly in the manual and are not repeated here.

Using the .MODEL directive imposes a predetermined segment order, but this fact is not referenced in the documentation. The linker rearranges the order of segments so that those with the same class name are contiguous. By default, the classes and the segments within them are arranged in the order that their declarations are encountered in the source. When using simplified directives, however, the first declaration of a segment class is created by the .MODEL statement and not by a segment directive such as .CODE or .DATA. For example, using .MODEL SMALL creates the same sequence of object records as the following sequence of directives:

```
_TEXT SEGMENT WORD PUBLIC 'CODE'
_TEXT ENDS
_DATA SEGMENT WORD PUBLIC 'DATA'
_DATA ENDS
DGROUP GROUP _DATA
    ASSUME CS:_TEXT, DS:DGROUP
```

Because the .MODEL directive must precede any other simplified segment declarations, it emits the first segment declarations into the object file, thereby determining the segment order. This causes all segments with the class name 'CODE' to precede those with the class name 'DATA', and puts the _DATA segment at the origin of DGROUP, regardless of the subsequent order of any explicit or simplified segment directives.

In many cases, the segment order in an assembly language source program is not important. For a standalone program that is in the form of an EXE file, any order is usually acceptable as long as the programmer specifies the proper entry point in the END statement. For a procedure that has been linked with modules created by a compiler, the segment order is determined by information in the compiled object files and is not dependent on the structure of the assembly language source program.

Sometimes, however, a specific order is necessary. In a .COM program composed of multiple segments in one group, the code segment containing the entry point must be first. In an OS/2 device driver, the default data segment must be first. Two options are possible for modifying the default segment order produced by MASM. The first is the ALPHA directive or the /A switch on the MASM command line; it arranges groups alphabetically by segment name and segments within groups alphabetically by name. The

TABLE 1: ***Segment and Class Names Within DGROUP***

DIRECTIVE	SEGMENT NAME	CLASS IN MASM 5.0	CLASS IN MASM 5.1
.DATA	_DATA	'DATA'	'DATA'
.DATA?	_BSS	'DATA'	'BSS'
.CONST	CONST	'DATA'	'DATA'
.STACK	STACK	'STACK'	'STACK'

The segment and class names for the components of DGROUP are constant across all memory models. The Microsoft Assembler *Programmer's Guide* incorrectly documents the class names generated by the .DATA? and .CONST directives.

IBM versions of MASM for DOS use this option by default; prior to IBM's version 2, the ALPHA directive was the only alternative. The second option is the DOSSEG directive, which arranges segments in the order used by Microsoft language compilers. This order places segments of class 'CODE' first, those belonging to DGROUP last (with a prescribed order within the group), and all other segments in between in source code order.

If neither of these options produces the desired order, the only other alternative is to manually declare segments in the proper sequence. This can be done in conjunction with simplified segment directives. For example, the following sequence puts the segments with class name 'DATA' ahead of those segments with class name 'CODE', and ensures that the CONST segment is first in the DATA class.

```
CONST SEGMENT WORD PUBLIC 'DATA'
CONST ENDS
    .MODEL  . . . .
```

It is important that the segment name, align-type, combine-type, and class name in the explicit declaration be the same as those in the implicit declarations issued by the .MODEL directive. However, this defeats one of the major purposes of simplified segment declarations: relieving the programmer of the need to remember these attributes. If any segments must be explicitly declared, it is usually more convenient to dispense with the simplified segmentation directives altogether and use full declarations for all segments, especially in a stand-alone program where only the order and not the naming of segments is significant.

2 TURNING OFF NUMLOCK IN OS/2

The 101-key enhanced keyboard has been standard on IBM PCs and compatibles for over two years, yet many users still are not accustomed to using the dedicated cursor control keys distinct from the numeric keypad. It annoys them that the system turns on the keypad's NumLock state at boot-up. Under DOS, the problem is easy to fix with a four-instruction program executed from the AUTOEXEC.BAT file:

```
MOV   AX,40H
MOV   DS,AX
AND   BYTE PTR [17],0DFH
INT   20H
```

This resets bit 5 in the shift-state byte of the BIOS data area, turning off both the NumLock state of the keypad and the indicator light.

Under OS/2, the NumLock state at boot-up is even more annoying because the initial screen displayed by OS/2 is the Program Selector. Starting an application requires the user to move a highlight around a menu. Therefore, on a system without a mouse, the first activity that the user must perform is to press a cursor key.

The DOS program given above does not work in OS/2 because, in protected mode, programs are prevented from accessing arbitrary memory locations. An application-level program cannot request access to an absolute address. Fortunately, OS/2 provides API services for many of the functions that DOS programs perform by direct access to hardware, and the KbdSetStatus function for setting the shift state of the keyboard is one of them. Unfortunately, this function is not useful for setting the state immediately after boot-up.

An application-level program that calls KbdSetStatus can be executed from OS2INIT.CMD (the protected-mode equivalent of AUTOEXEC.BAT), but OS2INIT does not run until a pro-

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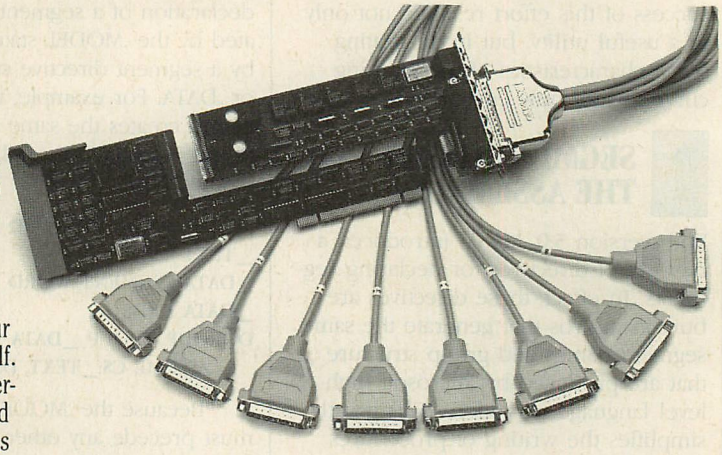

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tected-mode session is started from the program selector. The objective is to turn off the NumLock state *before* the program selector starts up.

The user may execute application programs prior to the program selector by naming them in a RUN command in the CONFIG.SYS file. However, a program executed this way runs as a detached background session with no access to the physical console; therefore, it cannot affect the status of the keyboard with KbdSetStatus. It can force itself into the foreground and gain access to the console with VioPopUp, but any changes it makes to the keyboard are undone as soon as it relinquishes the console with VioEndPopUp (see "OS/2's Answer to TSR's," Dan Rollins, May 1988, p. 84). Calling KbdSetStatus while in control of the console momentarily blinks the NumLock light but has no lasting effect.

The CONFIG.SYS file also executes programs through the DEVICE statement. OS/2 loads the driver named in the DEVICE statement and calls its strategy routine with an initialization request. The driver can get control of the keyboard, set the shift status, and then refuse to install itself, performing its function as if it were a transient program. This process can be made to work, although somewhat differently than expected.

During installation, a device driver can use a subset of the API services, but the keyboard functions are not in that subset. Therefore, the device driver must use some method other than the KbdSetStatus function. One such method is to directly manipulate the BIOS data area. Because the driver executes at the highest privilege level, it has direct access to all system resources, including direct access to absolute addresses.

The BIOS data area is already mapped into the driver's address space with a bimodal address. In other words, the protected mode selector is 40H, the same as the physical segment address. The addressability of BIOS data is undocumented, however, and an alternative method exists. A device driver can request access to an absolute memory location by converting its physical address with the PhysToVirt function of the DevHelp services. (For details, see "Designing Drivers for OS/2," David A. Schmitt, Part 1, December 1987, p. 164, and Part 2, February 1988, p. 136.) In this case, the driver passes the address 417H to PhysToVirt and receives the protected-mode address in either DS:SI or ES:DI.

It does not matter how the device driver obtains access to the shift-status byte because changes to that byte have no effect on the NumLock state of the keyboard. At this early stage in its life, the operating system does not use the contents of the BIOS data areas to maintain hardware status.

Another approach is to use the API services for device I/O control. The function DosDevIOCTL is on the list of services that a device driver can use at initialization, and one of the IOCTL functions allows the setting of the keyboard's shift state. IOCTL functions are performed on open handles, and the keyboard is already open as standard input on handle zero. Unfortunately, this also fails—the error code given is "invalid command," indicating that handle 0 does not support the keyboard IOCTL functions.

The seemingly obvious answer—that a device driver does not inherit handle 0 as standard input—is disproved by two simple tests. First, the device driver can accept keyboard input simply by reading handle 0 without opening it. Second, the IOCTL call for handle 0 fails in the same way even

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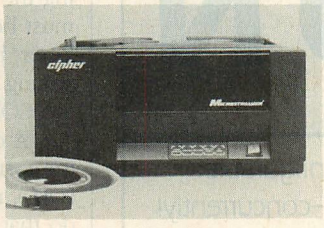

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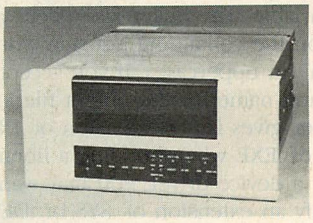

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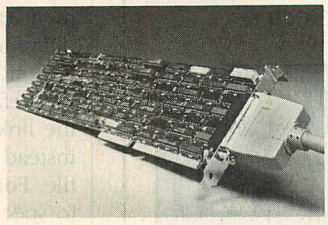

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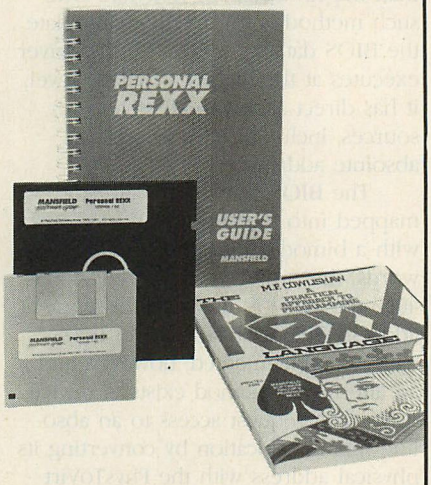

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from an application-level program where this handle undoubtedly refers to the keyboard. I am still determining the answer to that one and will report what I find in a later column.

The solution, however, is now close at hand. The device driver only needs to open the KBD$ device on a new handle, to set that handle's shift state with DosDevIOCTL, and then to close the handle. This process is implemented by the device driver OS2NLOK.ASM (shown in listing 1).

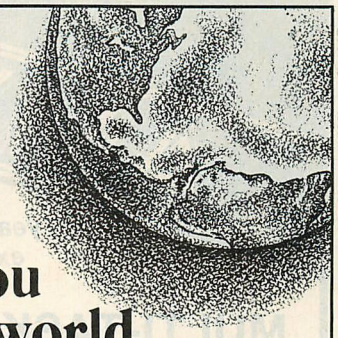
Several programming details should be mentioned. The code segment must be given the class name 'CODE' for the linker to build the executable file; on the other hand, segment names and other attributes can be chosen arbitrarily. The shift status consists of three bytes of information, one being related to multibyte foreign character sets. For compatibility with the National Language Support feature of OS/2, the contents of that byte are left unchanged by first obtaining the shift status with one IOCTL call before setting it with another.

The final action performed by the device driver is the setting of completion and error codes in the status byte and of the resident lengths of the code and data segments. Because this device driver has performed its entire function at initialization, it indicates zero lengths so as to leave none of itself resident. When OS/2 receives these values, it reports a driver installation error, even if the error bit is turned off. By default, error messages displayed by OS/2 during the processing of CONFIG.SYS must be acknowledged by pressing Enter, but this can be avoided by inserting PAUSEONERROR = OFF into the CONFIG.SYS file.

A device driver must be built in the format of a dynamic link library (DLL), not a stand-alone .EXE file. To do that, you can assemble it with any MASM-compatible assembler, then link it with the OS/2 linker. Next, specify DOSCALLS as the link-time library; it must be in the current directory or on a path mentioned in the LIB environment variable. The linker also needs a definition file containing just one word, LIBRARY (in uppercase). If you accept the default name for the output file, the linker gives it the extension of .DLL instead of .EXE when building a library file. For a device driver, you may want to specify an extension of .SYS or .DEV. Insert a DEVICE statement into the CONFIG.SYS file and NumLock will always be off at boot-up.

LISTING 1: OS2NLOK.ASM

```
;*************************************************************************
;
; os2nlok - OS/2 Device driver to turn off NumLock state of keyboard.
;          Performs its function at initialization, does not
;          install itself.
;
; Copyright (c) 1988 PC Tech Journal and Ziff Communications Co.
;
;                    Written by Ted Mirecki
;
;*************************************************************************

          .286                    ;enables 'push immediate' instr.

;*************************************************************************
; Declarations:  OS/2 API functions;
;                Device driver request packet:
;                    - standard request header
;                    - header extension specific to init request
;                Bimodal address of request packet is in ES:BX
;                at entry to strategy routine.
;*************************************************************************

          extrn   DosPutMessage:Far
          extrn   DosDevIOCTL:Far
          extrn   DosOpen:Far
          extrn   DosClose:Far

devpacket  struc                  ;Device driver request packet
req_len    db      ?              ;standard request packet header
req_unit   db      ?
req_comm   db      ?
req_status dw      ?
req_res    dd      ?
req_queue  dd      ?
                                  ;rest of packet for init request:
init_data1 db      ?              ;block count (zero for char device)
init_ecode dw      ?              ;resident segment lengths
init_edata dw      ?
init_ptr2  dd      ?              ;unused by char device
devpacket  ends

;*************************************************************************
; DATA segment:  begin w/device header, follow w/local data
;
; Use explicit segment declarations, not simplified ones,
;    to ensure proper segment order (data segment first).
;*************************************************************************

data       segment
           assume ds:data
                                  ;DEVICE DRIVER HEADER:
devhdr     dd      -1             ;device header linkage
devattr    dw      8080h          ;bit 15 = char device,
                                  ;bit  7 = OS/2 driver
deventry   dw      offset strategy     ;offset in code segment
           dw      ?              ;reserved
devname    db      'OS2NLOK '     ;device name, must be 8 chars
           db      8 dup (?)      ;reserved
                                  ;end of header
CR         equ     0Dh
LF         equ     0Ah
RESET      equ     not 20h        ;reset num lock bit

signon     db      CR, LF, 'Numeric Unlock, OS/2 version', CR, LF
           db      '  Copyright (c) 1988 PC Tech Journal and'
           db      ' Ziff Communications Co.', CR, LF
           db      '  Written by Ted Mirecki', CR, LF, LF
lenmsg     equ     $-signon
                                  ;data for open call
kbd        db      'KBD$', 0
handle     dw      ?
action     dw      ?
                                  ;data area for IOCTL calls
shift      dw      ?              ;word for shift flags
nls        db      ?              ;byte for NLS shift status

data       ends
```

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```
;*****************************************************************
; CODE segment: strategy routine, performs initialization only.
; Processing: 1. Display message
;             2. Open KBD$ device
;             3. Get shift state w/IOCTL call
;             4. Change NumLock, call IOCTL to set shift state
;             5. Close KBD$ device
;             6. Return to kernel without installing.
;*****************************************************************

code        segment 'code'
            assume  cs:code
strategy    proc    far

; 1. call DosPutMessage(0, lenmsg, @signon)
            push    1               ;handle 1 = std output
            push    lenmsg
            push    ds              ;far address of message
            push    offset signon
            call    DosPutMessage

; 2. call DosOpen("KBD$", @handle, @action, 0L, 0, 1, 12h, 0L)
            push    ds
            push    offset kbd      ;device name
            push    ds
            push    offset handle   ;returned handle
            push    ds
            push    offset action   ;returned new/existed flag
            xor     ax,ax
            push    ax              ;initial file length = dword 0
            push    ax
            push    ax              ;file attribute = word 0
            push    1               ;fail if file non-existent
            push    12h             ;not sharable, r/w access
            push    ax              ;reserved: dword zero
            push    ax
            call    DosOpen

; 3. Get shift status for handle opened above:
;    call DosDevIOCTL(@data, @parm, function, category, handle)
            push    ds              ;far addr of data area
            push    offset shift
            push    ds              ;use same addr as parm area
            push    offset shift
            push    73h             ;function 73: get shift status
            push    4               ;category 4: keyboard IOCTL
            push    handle          ;handle from previous open call
            call    DosDevIOCTL

; 4. Reset NumLock bit, call DosDevIOCTL as above to set shift status
            and     shift,RESET     ;reset bit in Kbd status word
            push    ds              ;far addr of data area
            push    offset shift
            push    ds              ;use same addr as parm area
            push    offset shift
            push    53h             ;function 53: set shift status
            push    4               ;category 4: keyboard IOCTL
            push    handle
            call    DosDevIOCTL

; 5. Close the KBD$ handle: call DosClose(handle)
            push    handle
            call    DosClose

; 6. Terminate w/o installing
            xor     ax,ax           ;set code & data lengths to zero
            mov     es:[bx].init_data1,ah
            mov     es:[bx].init_ecode,ax
            mov     es:[bx].init_edata,ax
            mov     es:[bx].req_status,810Ch ;set return status:
                                             ; bit 15 = error
                                             ; bit  8 = done
                                             ; bits 0-7 = error code
            ret
strategy    endp
code        ends
            end
```

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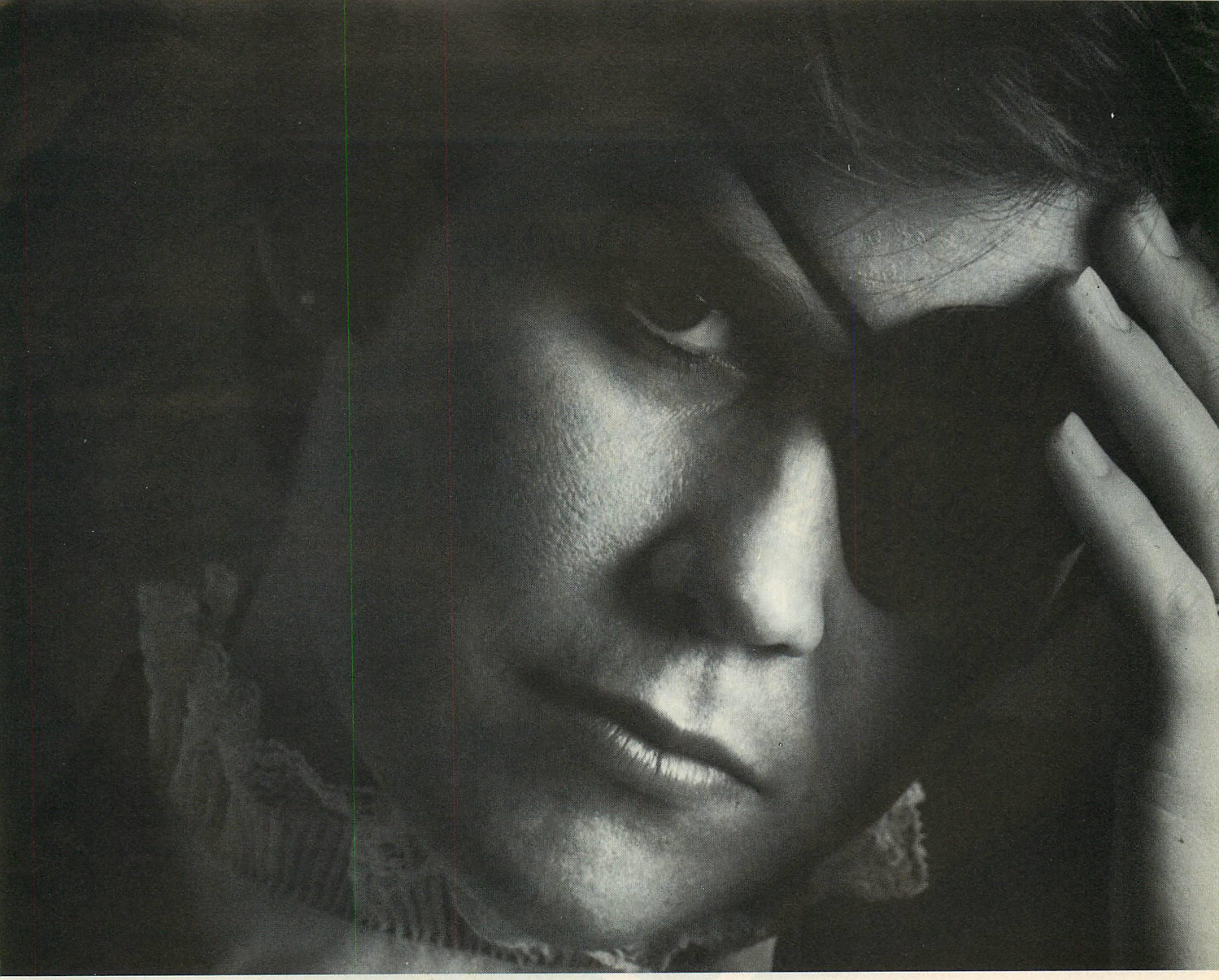

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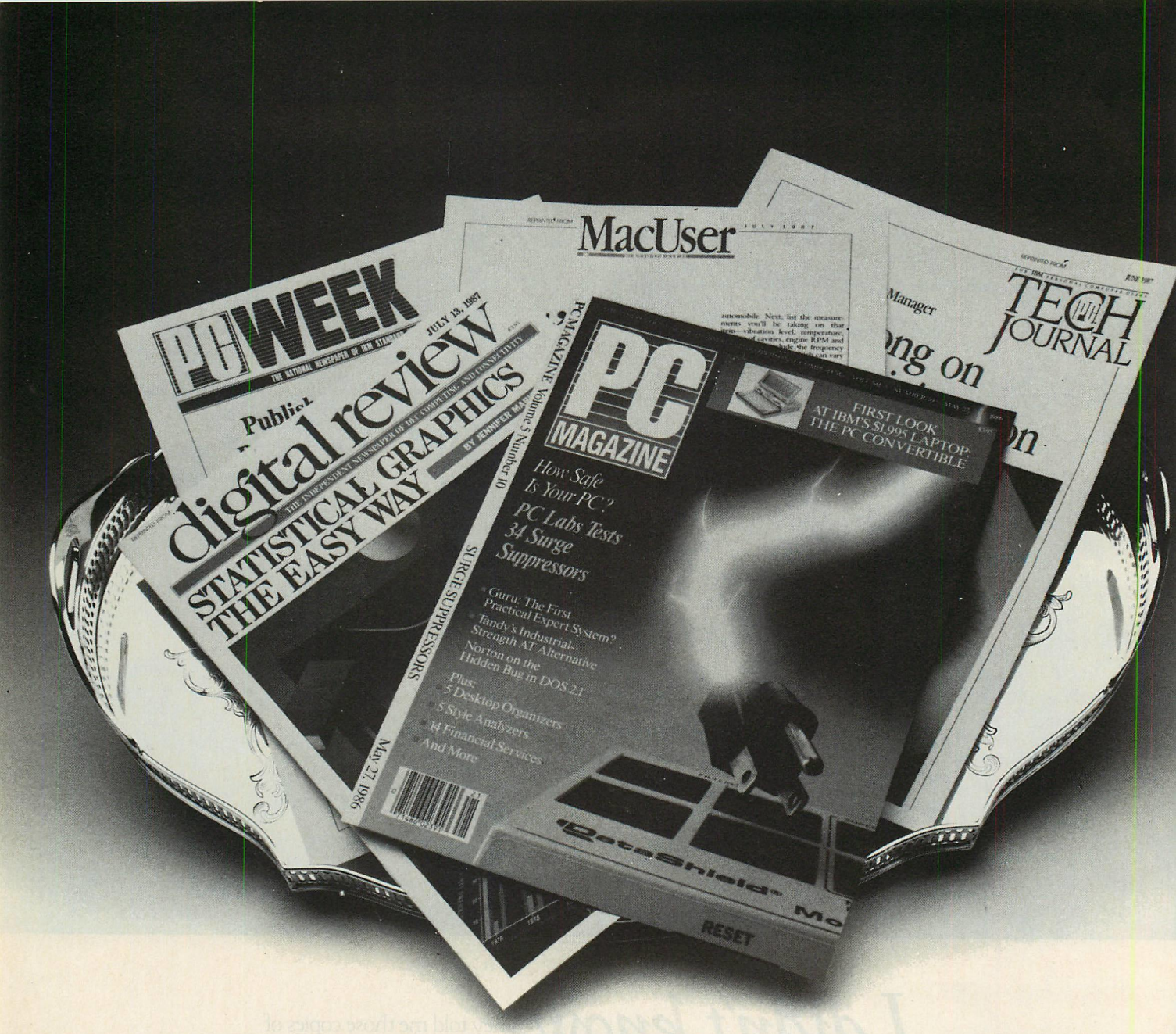

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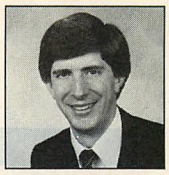

Having it Both Ways

The assembly line is an obsolete model for software integration. Today's environment demands a double-backbone design.

The accepted assembly-line perspective on data processing has been with us for decades: raw input comes in at one end and moves through successive stages to become more and more human-readable at the other end. Individual accounting transactions turn into general ledger accounts, then into consolidated reports, and finally into presentation graphics for the annual meeting.

Now that desktop publishing can make the entire process take place on a single affordable machine, a growing number of users are demanding this kind of flow-through integration between their various applications, but the assembly-line approach no longer may be sufficient. What developers and integrators should turn their sights to now is what I call the double-backbone model (see figure 1).

The essence of the double-backbone model is its distinction between acquiring and managing data on the data backbone as opposed to reporting and presenting data on the output backbone. Users generally understand—and are full of ideas for—the presentation technologies, but the data management view is usually neglected in systems design and implementation. Developers and integrators must therefore take the lead.

A BETTER WAY

One of the companies I support relies on its microcomputers to generate customized mass mailings: the mail-merge features in today's word processors are helpful, but in most cases are not directly coupled with the programmable database capabilities needed to speed mailing-list data entry and automate the analysis of content.

The answer to this problem has been software bridges—for example, special-purpose programs that generate the mail-merge data-format file as a database report; each such utility must be built manually. The resulting system may meet the company's needs, but it started me thinking there must be a better way.

I have recently been working with another group of clients who are introducing workstations for interactive analysis and reporting of the data they develop on a multi-mainframe system. They want mainframe output to flow smoothly into statistical packages and from there (with analysis) into coordinated presentation graphics and desktop publishing systems.

Everyone in the group tried hard to force-fit this description into the assembly-line model. In making sure that each application would accept input from the one *before* and produce output usable by the one that came *after*, they kept discovering they wanted to pass information over a variety of paths, depending on the various situations that might arise. Furthermore, they needed to pass the information around to one another in two different forms: one that lent itself to document preparation and another that was for use by other applications.

These clients thought they had discovered a contradiction in their requirements; I think what they actually discovered was the double backbone—a new view of software integration. I would like to offer it as an alternative for selecting and integrating tools for your own user community.

DON'T GET IN THE WAY

When users describe their goals for computer-based task support, they often concentrate on the output. This focus stems partly from fear: they know that many systems demand an Olympian effort just to manipulate data the way scissors and paste have been doing with paper for centuries.

By focusing on output, users often fail to give the developer adequate insight into how the system can improve their *process* of developing results. Never having thought about their files of purchase orders and supplier contacts as "relations," for example, users may not recognize the advantages a relational database has over a simple flat-file manager.

Given a user community with sufficiently little knowledge of computers, and developers with sufficiently little knowledge of the business (even though they very well may work for the same company), the best result that can be hoped for is the successful automation of the existing manual system. One observer has called this practice

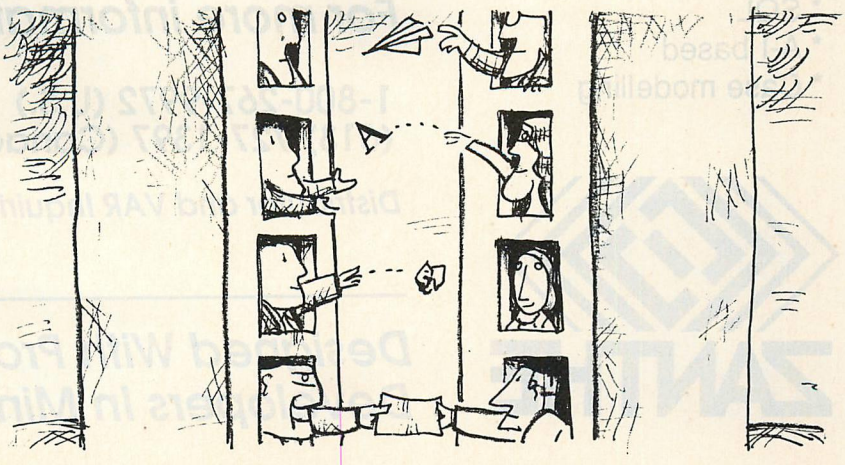

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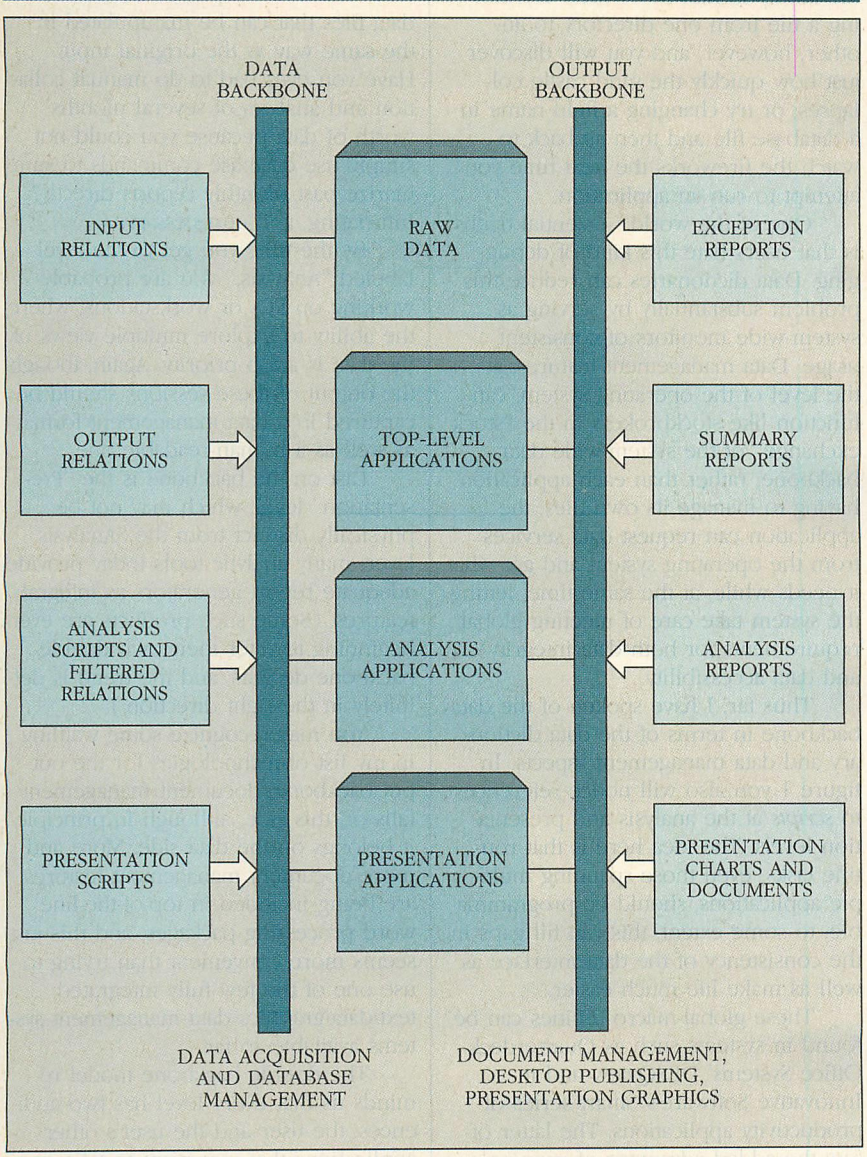
FIGURE 1: ***The Double-backbone Model***



An alternative to the assembly-line view on data processing, the double-backbone model distinguishes between data management (the data backbone shown on the left side) and data presentation (the output backbone on the right side).

"paving over the cow paths," the suggestion being that it might be better to straighten them first. It is the developer's responsibility to recognize, even if the users may not, the potential for future enhancement and integration of what may initially be stand-alone applications. Keeping these options open for the future requires planning for data interchange today.

The first step in having applications exchange data is to have the data on-line. It is at this initial threshold that many systems trip and fall. In many organizations, even those with ample computing horsepower, it is amazingly difficult to get a handle on what information resides where in the total system. A complete picture usually turns out to require that the system be defined to include file cabinets as well as file directories, desk drawers as well as electronic desktops.

Two factors keep much of the relevant information off-line. The first is that most organizations are woefully under-invested in facilities for high-speed input, as opposed to processing and output. Many users with 80386-based PCs are still using antiquated 1,200-bps modems; many offices with one or more laser printers are still entering external documents into their on-line system by retyping rather than using one of today's increasingly reliable and affordable scanners.

The second factor, which also contributes to the first, is the scant payoff for the effort of getting information into the computer in the first place. Central paper files are more of a collective resource than on-line files on stand-alone PCs; even if the PCs are networked, how many users voluntarily go to the trouble of putting files of common interest into commonly accessible areas instead of just leaving them in their own (presumably private) working directories?

Even if the information resides in a public directory, few systems provide the tools for convenient searching, except perhaps on primitive string-matching criteria. Today, systems for free text indexing, proximity searching, and so on are readily available; the number-crunching history of computing may explain the general failure to take full advantage of these tools, but it can no longer excuse it.

Until we (as systems developers and integrators) deploy these tools to enhance accessibility, users will not be inclined to make their information available. If they perceive no payoff, nothing short of the Thought Police will get the collective pool of information assets into a usable on-line form.

Giving the users positive returns on their efforts to put information into a system requires the full power of data management techniques. At the same time, developers have to meet users' rising expectations for higher levels of polish in the presentation of output to customers and management. These seemingly contradictory goals can be achieved by adopting the double-backbone model in figure 1.

THE DATA BACKBONE

The core technologies on the left-hand backbone are data acquisition and management. A word to the wise: if you don't use a system with a true data dictionary, then the data backbone will be a limp thread rather than a strong supporting structure. Vendors use the term *data dictionary* in various market-driven ways. Myles Walsh delivers an adequate definition in his essay on "Software and Data Security" in the second edition of the *Computer Security Handbook* (Hutt et al., Eds.; Macmillan, 1988): a data dictionary is "a centrally located repository containing descriptions of files or databases used by the programs."

Most applications do their own data management—to use the term quite loosely. Spreadsheets deal with

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individual files, and a few even have the ability to link those files. Try moving a file from one directory to another, however, and you will discover just how quickly the sand castle collapses; or try changing a field name in a database file and then sit back to watch the fireworks the next time you attempt to run an application.

One of the world's essential truths is that users hate this kind of debugging. Data dictionaries can reduce this problem substantially by serving as system-wide monitors of consistent usage. Data management features, at the level of the operating system, can function like stockbrokers in the "stock exchange" of the system-wide data backbone; rather than each application having to manage its own files, the application can request data services from the operating system and get what it needs while, at the same time, letting the system take care of meeting global requirements for both data integrity and data accessibility.

Thus far, I have spoken of the data backbone in terms of the data dictionary and data management aspects. In figure 1 you also will notice references to *scripts* at the analysis and presentation levels. The idea here is that routine tasks, even those spanning multiple applications, should be programmable; to some extent, this can fill gaps in the consistency of the data interface as well as make life much easier.

These global-macro utilities can be found in systems such as Quarterdeck Office Systems' DESQview and in Innovative Software's Smart series of productivity applications. The latter offers the added advantage of running with compatible data files under a wide range of operating systems, including but not limited to DOS.

PUTTING IT TO WORK

To make the data backbone effective, developers and integrators must pay attention to the output backbone. At the "Raw Data" level, the output backbone includes exception reporting, as shown in figure 1. This means the system should be able to use some of its MIPS to tell you *now* of certain critical conditions. You would do well to exercise some discipline here, however; if you try to do everything at this level, your users will never see anything but these reports and will not get an interactive feel for what's going on.

Moving down the backbone, most of the applications labeled "Top-Level" in the figure are probably mainframe-based; the output from these applications should be captured in relational data files that can be manipulated in the same way as the original input. Have you ever had to do manual collation and analysis of several months' worth of data because you could not simply use database commands to summarize past monthly reports directly? Infuriating, and unnecessary.

By the time you get to the level labeled "Analysis," you are probably working on PCs or workstations, where the ability to explore multiple views of the data is a top priority. Again, though, the output of these sessions should be captured in a data management format as well as a human-readable one.

Last on the backbone is the "Presentation" level, which may not be physically distinct from the "Analysis" layer; many analytic tools today provide adequate report generators as integral features. (Some such products are even beginning to offer their own double-backbone designs, and the trend is definitely in the right direction.)

You may recognize some waffling in my list of technologies for the output backbone; document management falls on this side, although in principle it belongs on the data side. More and more document management features are being included in top-of-the-line word processing packages, and this just seems more convenient than trying to use one of the few fully integrated text/data/graphics data management systems available so far.

The double backbone model reminds us that every level has two audiences: the user and the user's other applications that may want to take another crack at the intermediate results. It forces us to think about keeping both sets of options open at every point along the path from initial data to conclusions.

The double backbone provides a clean, consistent approach to the design of a system. For each function that the system performs, you can simply ask, "What does the system know? And what part of what it knows do we want it to tell us?" Today, applications must not only work together, but also report together. Neither capability is sufficient by itself, and users are getting tired of filling in the gaps.

Peter C. Coffee is managing partner of SolveWare, a developer and business computing consultant, and is active in AI and distributed computing applications for aerospace and educational clients.

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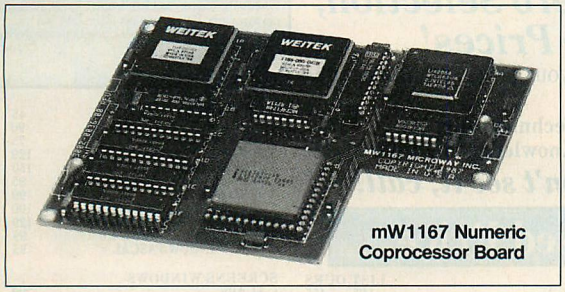

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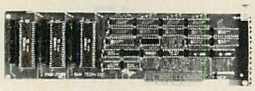

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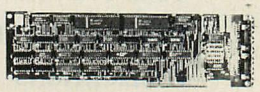

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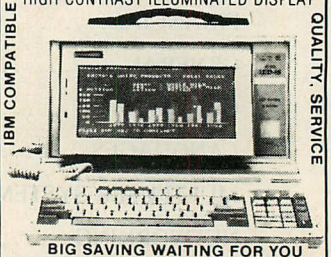

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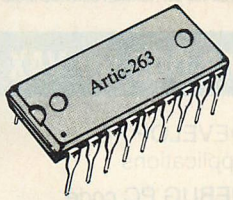

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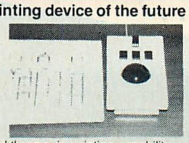

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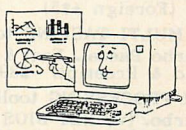

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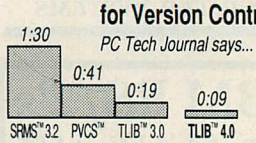

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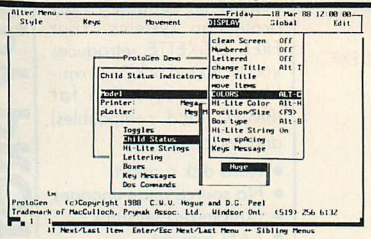

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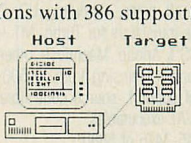

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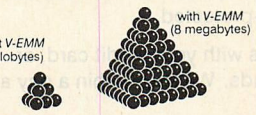

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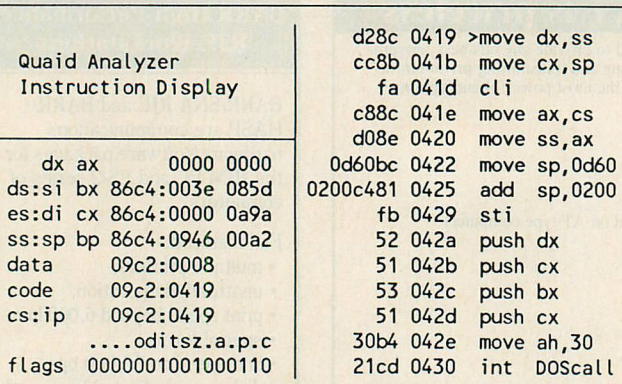

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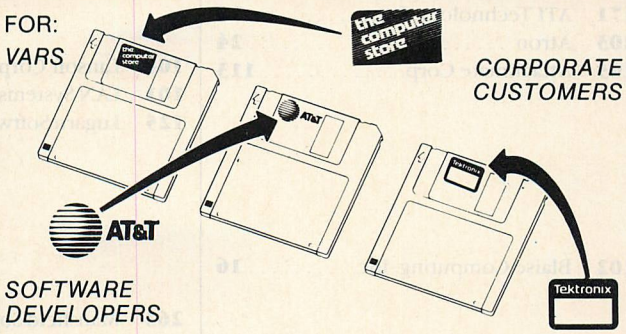

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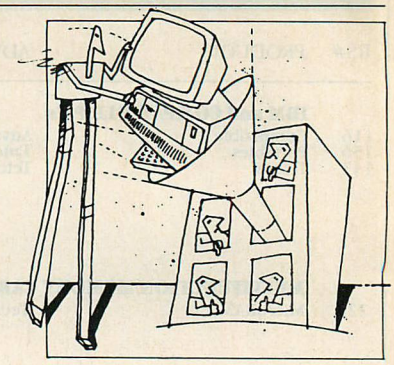
PROFESSIONAL VIEWPOINT



Initial rejection of PS/2 computers is due mostly to emotionalism and IBM's poor marketing strategy.

Many people in the PC community are rejecting IBM's PS/2 family of computers because they are upset with the company and uncertain about the hardware and software compatibility of the new Micro Channel Architecture. These are the findings of a recent informal *PC Tech Journal* survey in which 2 out of 3 respondents gave thumbs-down to the new IBM computer line.

On the other hand, respondents overwhelmingly support the PS/2 family's other major components—its Video Graphics Array (VGA) and its use of the more durable 3.5-inch diskettes. R. D. Cook, principal engineer at Gilbert/Commonwealth, Jackson, Michigan, tempers his support saying, "The VGA analog is excellent, colors are excellent, but resolution is limited. Using 3.5-inch diskettes is a good move, but the technology needs to mature."

Most complaints focus on the Micro Channel. Many respondents are not willing to switch to Micro Channel unless it is adopted by other vendors. Michael Fenske, vice president of Micro Technical Solutions Inc., Baltimore, Maryland, says, "Until the Micro Channel can be legally cloned, we will not be ready to subject ourselves to IBM's stranglehold."

The major issues associated with the PS/2 are performance, price, compatibility, and networking. Several respondents mentioned other products, including Compaq's Deskpro 386/20 and AST's Premium/386, as being far superior to the PS/2 in performance. However, this also can be said of earlier compatibles compared with the IBM PC/XT and PC/AT .

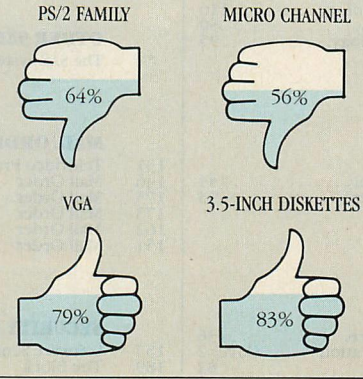
The PS/2 delivers less performance but carries an equivalent price tag, producing objections from those placing a high premium on a good price-performance ratio. Respondents noted that as the PS/2 infiltrates the market, as compatibles are built, and as more vendors produce PS/2 memory boards, they would expect PS/2 prices to go down and be less of an obstacle to buying the new machines.

Many respondents fear that using new PS/2 features in their applications will prevent them from being run on the AT and XT. David Olson, software engineer at Olson Research, Greenbelt, Maryland, says, "We must ensure that the software we develop operates on the entire family of PCs."

In terms of hardware compatibility, PS/2s can use the same hardware (printers and external modems) as compatibles. The new machines supply many standard features on the system board, such as realtime clock, video controller, and a serial and a parallel port. Special add-in boards are needed only if the user requires additional memory or if the machine is connected to a network. Some respondents complain of the expense and shortage of third-party expansion options, but many choices that will lower prices are now on the horizon.

The inability to interchange parts between the PS/2 and the AT- and XT-standard machines is a problem for respondents from major corporations that do repairs in-house. "The PS/2 has created a nightmare in our organization. The multiple standards have caused us to increase our spare parts inventory and have increased our staff for maintenance," says Ron Harrigal, mechanical engineer at the U.S. Mint in Washington, D.C.

Please give us your thumbs-up or thumbs-down rating on the PS/2 family.



Those supporting the PS/2 see it as a vast improvement over the AT and XT. It provides better cost-performance dividends, offers more reliability and ease of maintenance, uses less power, makes less noise, and takes up less desk space. PS/2 supporters also see few differences at the programming level and, therefore, little effect on software development.

Our readers' responses indicate a hesitant acceptance of the PS/2 family. IBM may have made a mistake by associating the PS/2 with OS/2 in its marketing efforts. It should have presented the PS/2 as an improved AT or XT that not only runs DOS and is compatible with most software and hardware, but also has a very promising future. Now, IBM must reevaluate its marketing strategy and pricing, and consider how it can "soup up" PS/2s to boost consumer acceptance.

The survey responses deliver a message that VGA and 3.5-inch diskettes are already accepted by the mainstream and are close to becoming standards themselves. The Micro Channel, on the other hand, is still unproven until boards emerge that take advantage of its new features such as multilevel bus arbitration.

Considerable interest exists for both the PS/2 and comparable 386 machines. While the PS/2 is not a huge success by IBM standards, it is favored by one-third of the respondents. For others, the PS/2's newness and its departure from prevailing standards have scared them into the waiting arms of the AT-compatible vendors.

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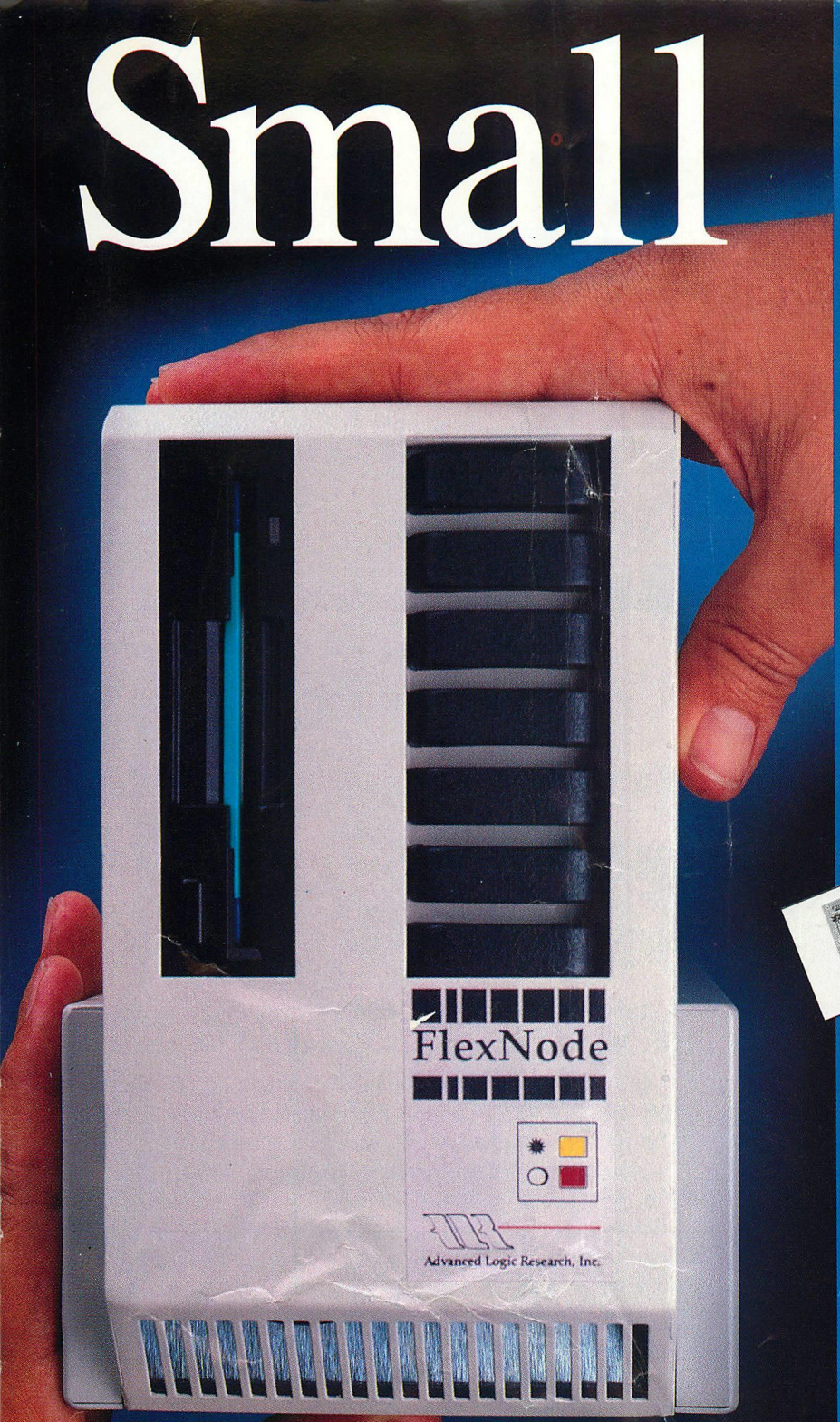

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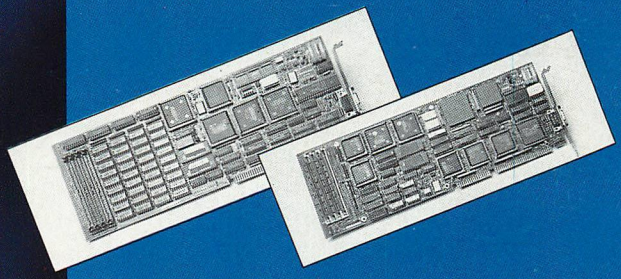

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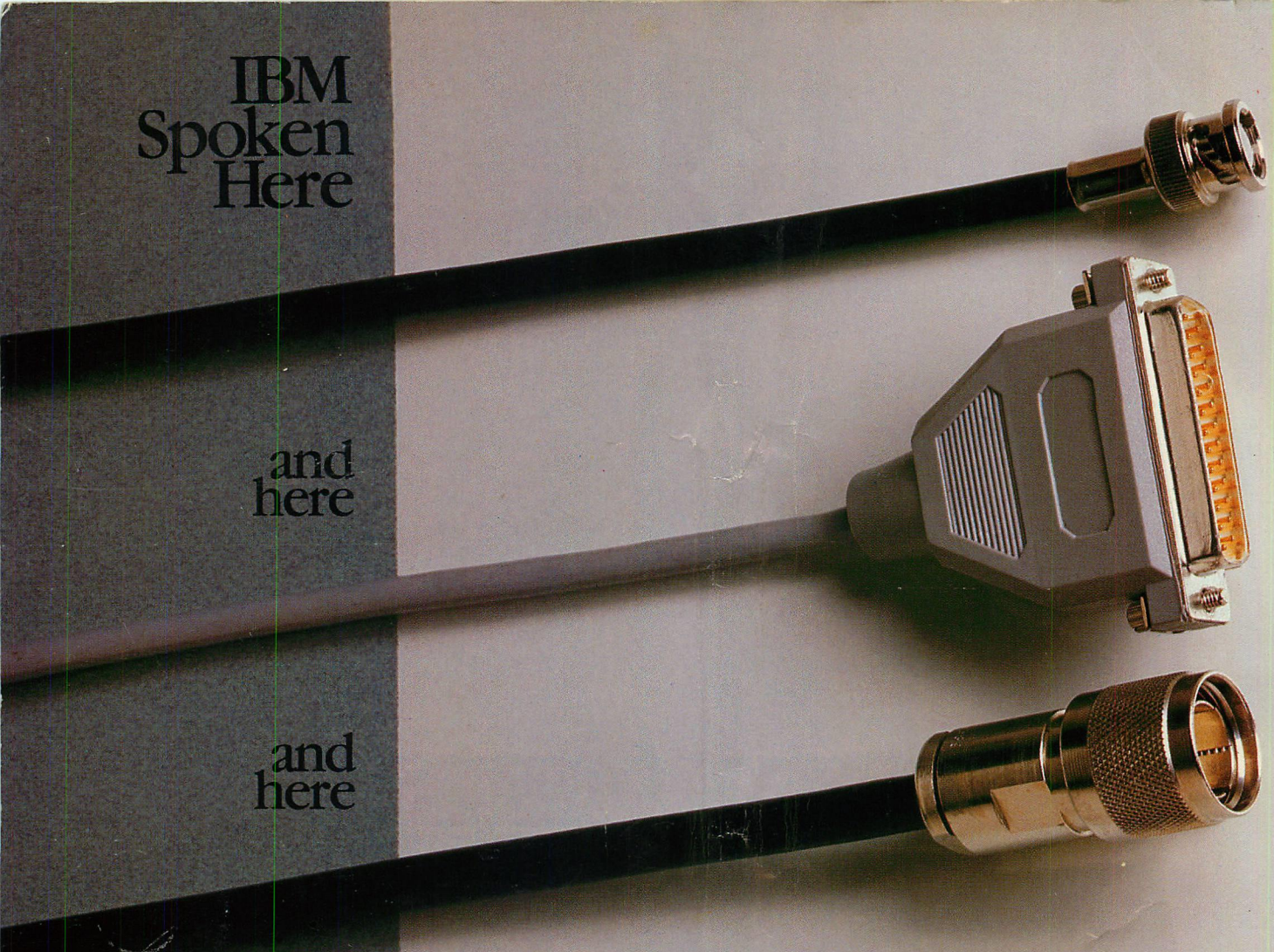

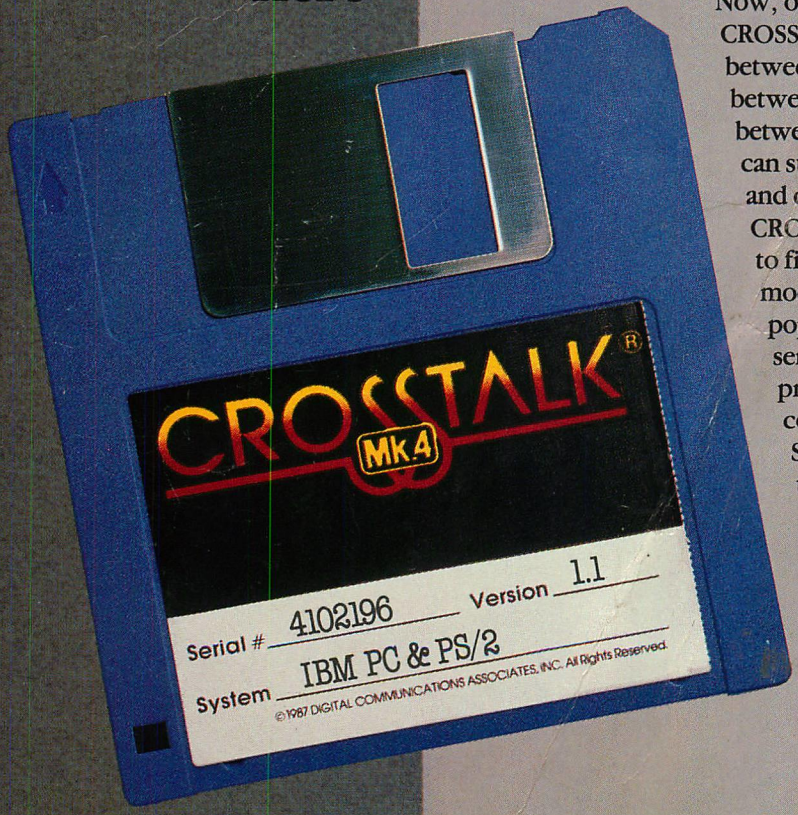

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